APRIL, 1960
Vol. 14, No. 4

FT food technology

Twentieth Annual Meeting of the Institute of Food Technologists

SAN FRANCISCO, CALIFORNIA, MAY 15-19, 1960
Masonic Temple, Fairmont Hotel, The Mark Hopkins Hotel

Concurrent Sessions	*Field Trips*	*Entertainment*
Food Additives	Napa Valley Wineries	*For the Ladies*
Food Enzymes		Welcoming Tea, Fairmont Hotel
Food Lipids	University of California, Davis	Tour of the City with Lunch at No. 9 Fisherman's Grotto
Food Proteins		Bay Cruise
Food Engineering	Tri-Valley Packing Association, Sun Sweet, Mission San Jose	Chinatown
Flavor Chemistry		Muir Woods via Golden Gate Bridge
Fruit Products	United Air Lines Commissary, Heublein, Stanford Research Institute	Trade Fair
Vegetable Products		*For One and All*
Citrus Products		Social Hour
Fish, Meat, Milk and Poultry	USDA's Western Regional Research Laboratory, Filice and Perrelli Company	Awards Banquet
Convenience and Instant Foods		Mexican Luncheon —Mexico Section of IFT
Quality Control—Statistical, Instrumentation	Ac'cent-International and Morton Salt	*Special Events*
Radiation Preservation of Food		Babcock-Hart Award Address
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Cereals	Hilo—tropical fruit production areas—coffee plantation and processing plant
Tropical Fruits and Fruit Products	University of Hawaii, Food Processing Laboratory
Poultry Meat	Banquet, Princess Kaiulani Hotel, Waikiki Beach
Tropical Fruit and Spice Products	Hawaii National Park, Hilo
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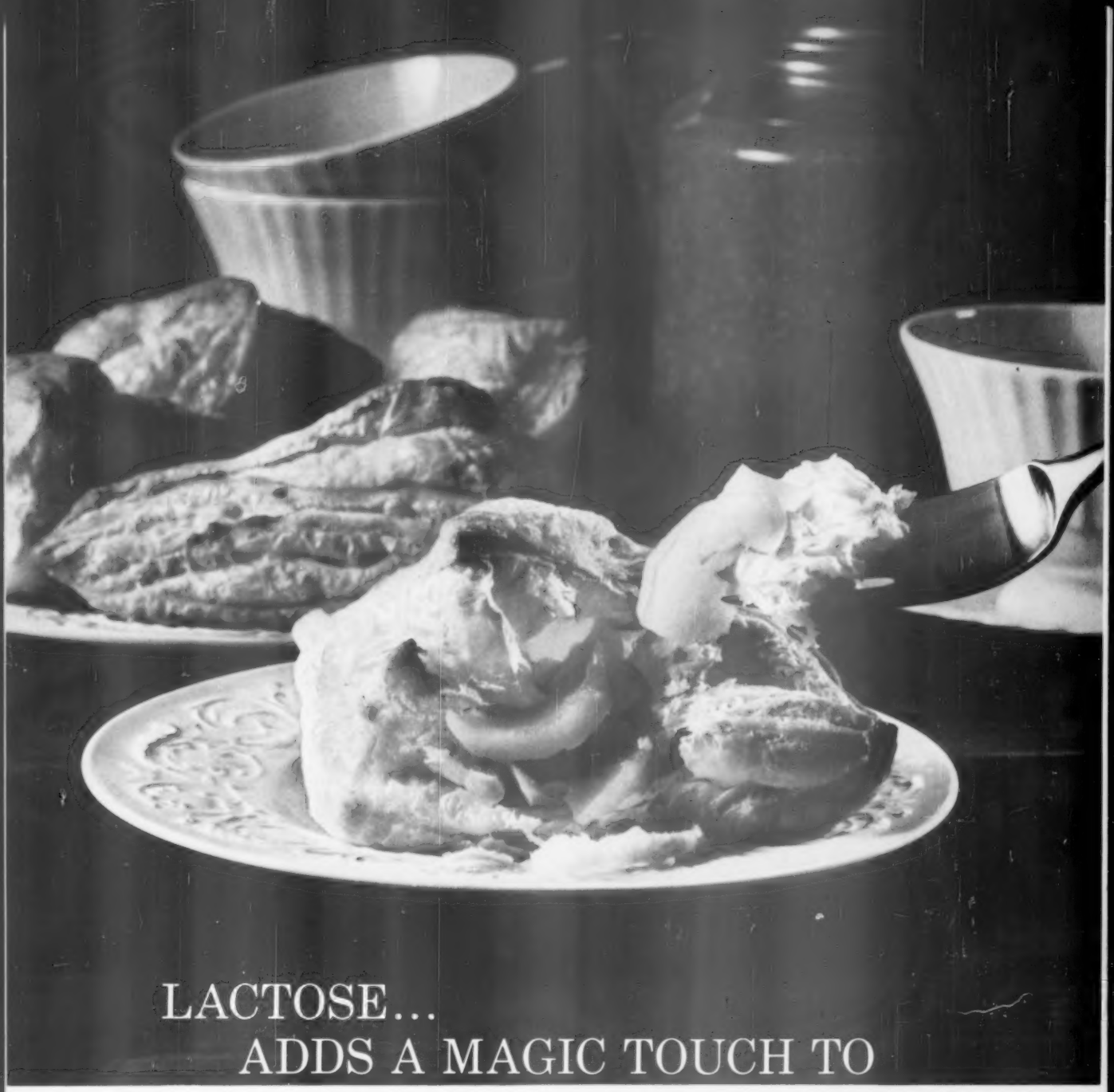

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Editorial Office
11606 South Bell Avenue
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THE GARRARD PRESS
510 North Hickory
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Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressd to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by The Garrard Press, Champaign, Illinois, U. S. A.

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Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.

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APRIL, 1960
Volume 14, Number 4

PUBLISHED MONTHLY BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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Improvement of Protein Value for Human Nutrition

With Special Reference to Supplementation with Lysine *

C. L. Wrenshall, Director

Technical Service Department, Chas. Pfizer & Co., Inc., 630 Flushing Avenue, Brooklyn 6, New York

PROTEIN MALNUTRITION is recognized as a serious problem in many parts of the world. The disease, kwashiorkor, is a severe protein deficiency syndrome commonly observed in poorly nourished children of under-developed regions, especially in Africa and Latin America. The symptoms may include growth retardation, liver lesions, dermatoses, lesions of the mouth and gastrointestinal tract, reduced production of enzymes, negative nitrogen balance, profound anorexia, edema, decreased muscle tone, apathy and a characteristic loss of hair pigmentation.

In addition to this frank protein deficiency disease of infants and young children, one finds in the protein-deficient regions high general morbidity, high mortality from infectious diseases of childhood, high incidence of gastrointestinal disorders, subnormal heights and weights in the population-at-large and, in general, conditions of ill health *(33)*. While it is difficult to relate all of these conditions specifically to protein deficiency, authorities are in general agreement that protein malnutrition is at least an important contributing factor. Specifically, protein deficiency is known to cause hypoproteinemia, anemia, poor wound healing, slow convalescence, liver injury and lowered resistance to infection, all of which contribute to the poor health conditions noted in protein-deficient regions.

Apparently there are varying degrees of protein malnutrition, from frank deficiency (kwashiorkor) on the one extreme through a wide range of debilitating insufficiency to what may be called suboptimal intake, which is adequate except under conditions of stress. Thus, the problem is an extremely broad one which may even be of serious concern in the better-nourished nations including the United States. There have been a number of nutritional and dietary surveys which show that suboptimal protein intake is commonplace in the U. S., occurring in every economic and social stratum *(9, 16, 28, 31, 36, 43)*. Infants, growing children of all ages, pregnant and lactating women, those chronically ill or convalescent and the elderly are groups with especially high protein needs and whose intake is most likely to be suboptimal.

This subject may be summed up in the words of Dubos and Schaedler *(17)*, "Protein deficiency is the most common and most important form of malnutrition in the world today." Therefore, any means of improving protein value for human nutrition is worthy of serious consideration. The improvement of protein quality by amino acid supplementation, particularly with lysine, will be discussed.

Protein quality. Differences in protein quality were first observed through feeding diets of different composition, but of equal protein content, to experimental animals such as weanling rats. Generally speaking, young animals grow much more rapidly on a given intake of animal protein than on the same intake of vegetable protein. On this basis it became apparent that the proteins of some foods are utilized more efficiently than those of other foods. From this has evolved the determination of the Protein Efficiency Ratio (PER)—the weight of normal body tissue laid down per unit weight of protein consumed, under carefully controlled experimental conditions.

Table 1 shows the PER for a number of common foods. These values indicate a considerable range of protein quality, making it impossible to classify some as superior without rating others as inferior. There is no doubt that the stigma of low-protein quality has attached itself firmly to the cereal foods as a class and has been a factor in down-grading them in the public esteem.

The superior quality of egg protein is quite striking. So far as I know, it has never been surpassed by any other food or combination of foods. Consequently, we are justified in regarding it as a criterion of protein quality. If something can be added to inferior proteins to make them nutritionally more like egg protein, their protein value will be improved.

Over the years, the unravelling of the chemistry of proteins has disclosed that they are made up of a number of amino acids. Nutritional research, keeping pace with chemical knowledge, has shown that several of these are nutritionally indispensable—that is, they cannot be made in sufficient amounts by the animal, but must be obtained from the food he

TABLE 1

Protein efficiency ratios (PER) of various foods[1]

Food	PER
Whole egg, dried	3.50
Fish flour	3.04
Whole milk, dried	2.70
Hamburger beef, dried	2.68
Soya flour	2.04
Beans, lima, cooked	1.72
Peas, cooked	1.57
"Protein" bread	1.29
Whole wheat bread	1.10
White bread, enriched	0.77
White flour, enriched	0.59
"Protein" cereal	0.03
Gelatin	−1.25

[1] Adapted from Chapman *et al (15)*.

* Presented at the Joint Meeting of the Southern California Section, Institute of Food Technologists, and of The Nutrition Foundation, Santa Monica, California, October 23, 1959.

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eats. Eight amino acids are essential in human nutrition. These essential amino acids are isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

The nutritional quality of dietary proteins is determined mainly by the amounts and relative proportions, or pattern, of these essential amino acids which they contain. In general, the closer the composition of dietary protein—in terms of its essential amino acid content—approaches that of egg protein, the higher its PER.

From all this has come the concept of comparing food proteins on the basis of their *patterns of essential amino acids*. To illustrate, Figure 1 shows the pattern of essential amino acids of egg protein, based on tryptophan as unity. For comparison, the pattern of the essential amino acids of white wheat flour protein is also depicted.

The essential amino acid pattern of wheat protein compares favorably with that of egg protein, with one exception. The relative proportion of lysine in wheat protein is slightly less than half that of egg protein. Lysine is the *limiting amino acid* in wheat protein.

Since lysine is the *limiting amino acid*, the other amino acids present can be utilized only to the extent that they are balanced with lysine. The excess of all the other amino acids shown as white bars in Figure 1, and representing about half the protein value of flour, will therefore be wasted unless additional lysine is supplied. Conversely the addition of 0.20% L-lysine, represented by the dotted line (Figure 1), is the key to unlocking the latent protein value of the flour. In fact, the PER of flour can be doubled by balancing its amino acid pattern with additional lysine.

Lysine is the limiting amino acid in a number of cereal foods. Normally, these cereal foods account for about 20% of the protein in the American diet. However, they may contribute up to 40% of the protein in the diets of persons of the lower economic groups *(28)*. More high-quality protein would appear to provide an obvious solution to the problem. Unfortunately, those who most need better protein, because of food habits, economic status or other reasons, often fail to eat sufficient high-quality protein.

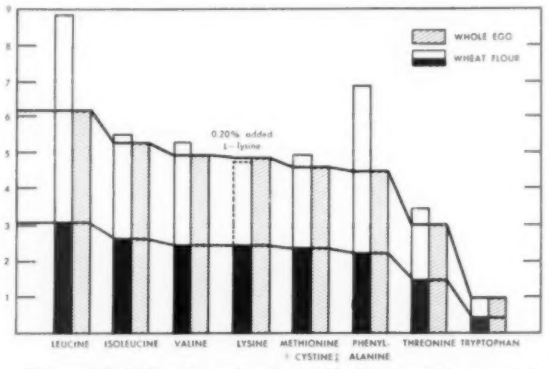

Figure 1.* Utilization of amino acids in wheat flour protein and in whole egg protein.†

Improvement of protein quality by amino acid supplementation. The fact that protein quality is determined by the pattern of essential amino acids has led to the recognition of the possibility of improving protein value by supplementing with the most limiting essential amino acid or acids. Since the classical work of Osborne and Mendel approximately 40 years ago, a large number of animal experiments reported in the literature have proved that such supplementation is highly effective. To do so in a practical, economical way then became a goal of nutritionists.

The amino acids are, as organic chemicals, relatively simple compounds. It should, therefore, be possible to synthesize them and so make them available individually for nutritional purposes. And this has indeed proved to be true. Methionine was the first commercially available synthetic amino acid. It is supplied as DL-methionine, which is fully as active as the natural L-isomer because the body can rearrange the D-isomer into the L-form. Methionine has proved to be both practical and economical and has been successfully used in certain animal feeds for a number of years. Indications are that it may also find practical application in human food.

* Based on data from Block and Bolling (1951). † Proportions based on tryptophan as unity. ‡ Part of the requirement for methionine can be supplied by cystine.

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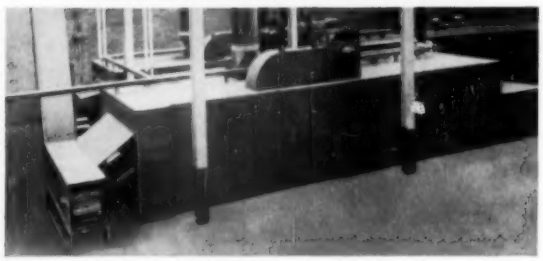

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The next essential amino acid to be introduced commercially was lysine. This has been made available by way of chemical synthesis, by hydrolysis of protein wastes and by fermentation. In the case of lysine, the DL mixture has only half the nutritional value of the L-isomer because the body cannot convert the one into the other. The commercial products obtained by hydrolysis and by fermentation are essentially all L-lysine. Synthetic L-lysine is obtained by resolution of the DL mixture.

Lysine is available today commercially as L-lysine monohydrochloride, equivalent on a weight basis to approximately 80% of the active L-lysine. L-Lysine monohydrochloride is a white crystalline solid, soluble in water. L-Lysine monohydrochloride is considered to be generally recognized as safe for food use and hence exempt from the Food Additive Amendment of 1958 to the Food and Drug Act. It is free from any objectionable taste or odor and can be used in food products without appreciably changing their organoleptic properties. This fact should be of interest to food technologists faced with the problem of improving a lysine-deficient food with the least possible change in its formula. Lysine thus lends itself to the improvement of diets in situations where resistance is encountered to change in food habits or to alteration of the character of traditional food staples.

Also, the addition of lysine does not change any of the other physical properties of the food product to which it is added. For instance, studies in our laboratories showed that lysine does not interfere with the fermentation of the dough during bread make-up and the volume and texture of the bread is equivalent to loaves containing no added lysine.

Commercial lysine was at first too expensive for general use in foods and feeds. However, the price of L-lysine monohydrochloride has rapidly declined from $34 per pound a few years ago to less than $5 now. At today's prices it is competitive with lysine commercially available in other forms, such as milk proteins and concentrated cereal proteins.

There is reason to hope that other essential amino acids may become commercially available in the future and, thus, eventually provide a flexible tool for tailoring the protein quality of any food or feed, meal or diet. For example, tryptophan and threonine produced by fermentation techniques are now available in research quantities. However, it is clear that the impetus for such a development must stem largely from the commercial acceptance accorded lysine.

SPECIAL CONSIDERATIONS REGARDING LYSINE

Lysine is in many respects the most important of all the essential amino acids, for several reasons:

Members of the Food and Beverage Technical Service "team" shown here (l. to r.) are: Charles Feldberg, Dr. Rouben Kachikian, Joan Griffin, Everett Macdonough—Manager, John Geminder, Edward O'Neill.

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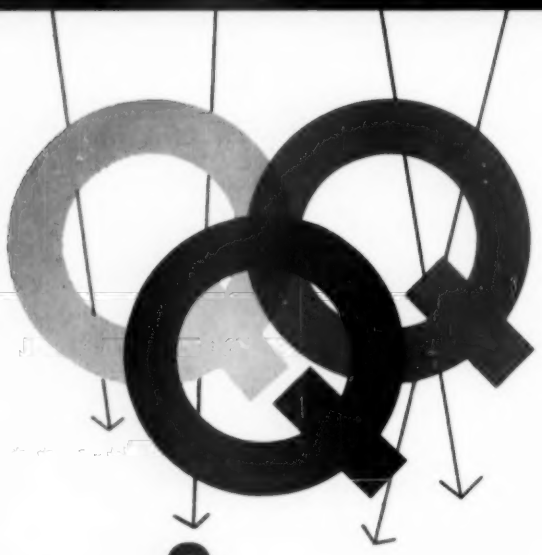

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1. The deamination of lysine is irreversible. Biochemical transamination reactions are common among the other amino acids, but lysine does not enter into these reactions. Other essential amino acids can be made by the animal from their alpha-keto or alpha-hydroxy analogues or from their unnatural D-isomers. Thus, while the others of our list are essential because the body cannot make them from other sources in sufficient quantity (or fast enough), L-lysine is in a class by itself, for the body cannot make it at all. We are therefore totally dependent on food sources for our supply of lysine.

2. Lysine is the first limiting amino acid in a number of important foods and, hence, in many human diets where these foods provide a major portion of the calories ingested. Lysine is usually the first limiting amino acid in diets mainly composed of wheat and rice, and is likely to be deficient in any diets where cereal foods are depended on heavily.

3. Of all the essential amino acids, lysine is the most easily destroyed or lost through food processing. For example, the outer layers of wheat are richer in lysine than the endosperm and, correspondingly, white flour is more deficient in lysine than whole wheat flour. Also, lysine is especially susceptible to destruction or loss of nutritional availability caused by heat processing. Many important manufactured foods have had their lysine value seriously reduced by milling and heat treatment *(11, 19, 42, 46)*. Table 2 shows the processing losses of lysine in ready-to-eat breakfast foods *(11)*. In fact, lysine may become limiting in entire diets because of heat processing losses *(39)*.

TABLE 2

Processing losses of L-lysine in ready-to-eat breakfast cereals[1]

Cereal	Raw cereal	Processed cereal	Lysine loss
	g lysine/16 g N	*g lysine/16 g N*	%
Corn flakes	1.9	0.9	52.6
Rice flakes	3.8	2.5	34.2
Wheat flakes	2.9	1.2	58.6
Wheat, puffed	2.5	1.1	56.0

[1] Adapted from Block and Weiss *(11)*.

4. As much as 50% of the lysine determined by chemical and microbiological procedures may be nutritionally unavailable for human nutrition *(8, 23, 31, 38)*. On this basis, the chemical composition figures reported in the literature do not provide a reliable quantitative measure of the nutritional availability of lysine values of various foods. For example, Gupta *et al (23)* reported a study showing that the natural lysine present in cereal proteins is not completely available as measured in simple rat growth studies. This is also true of certain animal proteins (Table 3).

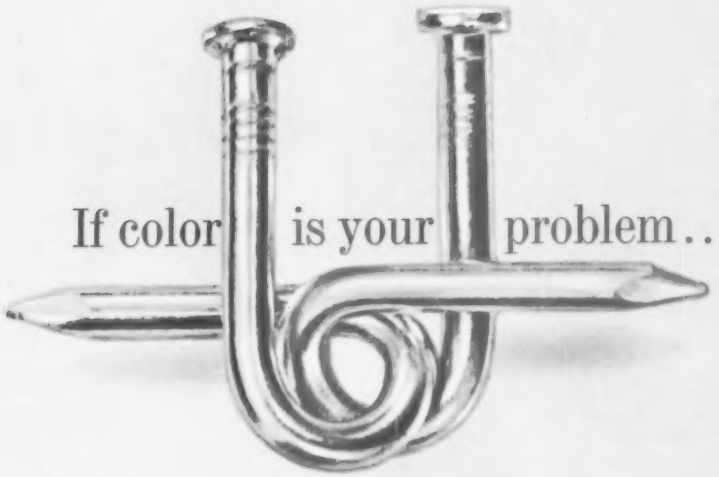
Objections to lysine supplementation. In view of the facts about lysine given above, it would seem that the concept of lysine supplementation of deficient foods would find ready acceptance. However, such is actually not the case. A number

TABLE 3

Nutritional availability of lysine in various foods[1]

Food	Lysine availability
	%
Soybean protein	118
Casein	104
Pork	100
Beef	89
Gelatin	94
Egg albumin	91
Fish flour	83
Spray-dried nonfat milk	92
Roller-dried nonfat milk	68
Corn	58, 49
Wheat flour	70, 72
Rice	86, 87

[1] Gupta *et al (23)*.



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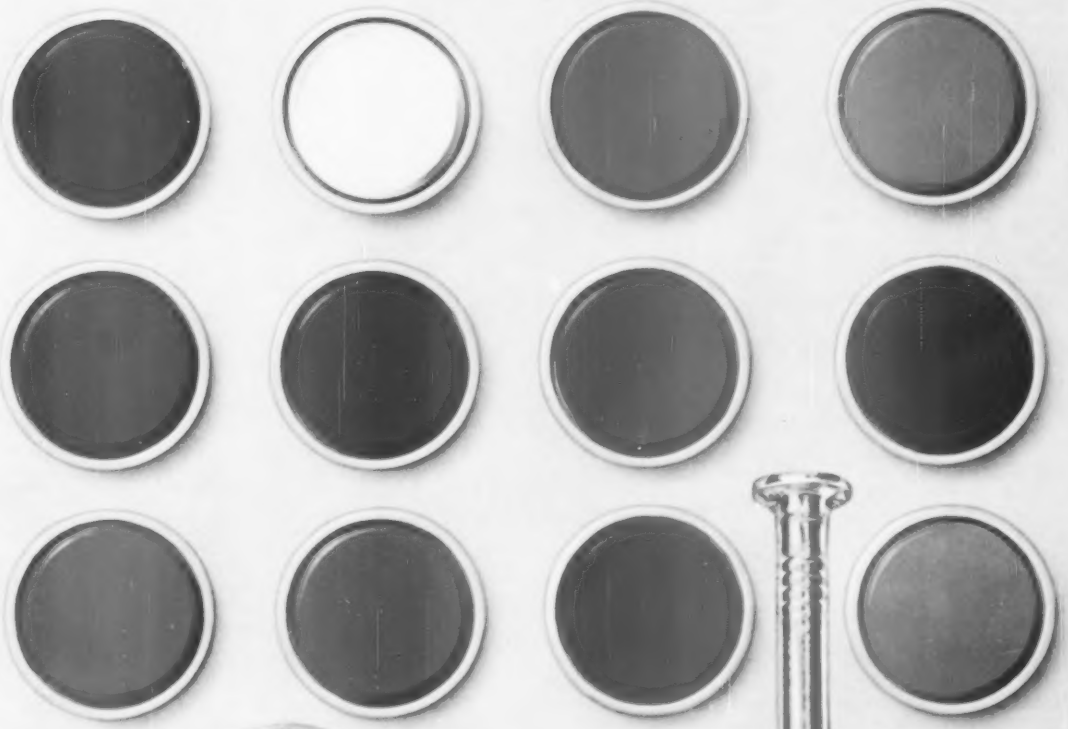

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of reasons have been advanced why lysine supplementation is thought to be unnecessary or even undesirable.

1. *Mutual Supplementation.* Some nutritionists maintain that supplementation of individual foods with specific amino acids is unnecessary because the high-quality proteins in the diet offset the deficiencies of the poorer proteins. It has been said that this is a situation wherein the total may be much greater than the sum of the individual parts—that is, a sort of synergism is thought to exist between proteins. For example, it is held that animal protein is an abundant source of lysine, and that when an animal food and a cereal food are eaten together, the lysine in the animal food supplements the lysine deficiency of the cereal so that both proteins are fully utilized.

Now it is perfectly true, of course, that nutritionally available L-lysine from *any* source is capable of supplementing a lysine-deficient protein, such as wheat protein by balancing its essential amino acid pattern. However, it should be equally plain that a given amount of lysine cannot, at one and the same time, balance the amino acid patterns of two proteins. Thus, it may be true that the proper amount of milk eaten together with a dry breakfast cereal provides enough lysine to balance the deficiency of the cereal. But, as Cannon *(13)* so aptly put it, . . . "the fact should not be overlooked that diversion of lysine from milk in order to atone for lysine injury in the cereal may render ineffectual the nutritive value of the remaining amino acids of milk."

The fact of the matter is that one protein can supplement another with lysine only to the extent that it contains *surplus* lysine—that is, lysine over and above the amount required to balance its own essential amino acid pattern. Thus, animal proteins are capable of supplementing cereal proteins with lysine only to a *very limited extent*—and not to the degree implied by many of the generalizations on this subject.

Howard *et al (26)* have given a clear exposition of this controversial subject, defining on a mathematical basis which agrees well with the experimental facts, the lysine supplemental value of various products. In this study the supplemental value of food proteins for wheat products was determined by the formula $S = Q \frac{L}{5.3}$ where: S = the supplemental value per 100 g; Q = the percentage of crude protein (N × 6.25) in the supplement; L = grams of lysine per 16.0 g N in the supplemental protein food; 5.3 = grams lysine per 16.0 g N in a "complete protein." On this basis they determined relative supplementary values of four food proteins and of lysine for wheat flour (Table 4).

Hutchinson *et al (27)* reported a study showing how difficult it is to attain maximum supplementation by combining proteins. Table 5 shows some of the protein efficiency ratio data contained in this report. As usual, whole egg protein leads the parade. A mixture of half bread and half egg protein is very good but significantly lower, with a clear improvement still attained by adding lysine to this mixture. Half bread and half milk protein falls considerably below these other values but is, of course, much better than the unsupplemented bread.

Such results suggest that it is possible to attain much higher PER's by supplementing with lysine in addition to milk protein and other protein supplements. Thus, lysine is not really competitive with these other commercial supplements but offers a means of attaining still greater improvement, far beyond what has been practical in the past. We have recently put this idea to the test by adding lysine to a commercial protein bread already improved with milk and soy proteins. The PER results shown in Table 6 indicate a very significant improvement which brought the protein quality of the finished bread practically on a par with milk protein itself.

TABLE 4

Relative supplementary value of various food proteins and lysine for wheat flour[1]

Protein source	Supplemental value[2]
Lactalbumin	149
Nonfat milk solids	58
Soybean protein	101
Wheat gluten	22
L-Lysine monohydrochloride	1,380

[1] Howard *et al (26)*.

[2] Determined by the formula $S = Q \frac{L}{5.3}$.

TABLE 5

Protein efficiency ratios (PER) of foods and food combinations, with and without lysine supplements[1]

	PER
Whole egg	3.7
Bread	1.3
Bread + whole egg (50 — 50)	3.0
Bread + lysine	2.6
Bread-egg (50 — 50) + lysine	3.6
Bread + milk (50 — 50)	2.7

[1] Adapted from Hutchinson *et al (27)*.

2. *The "Average" Situation.* The value of protein supplementation in the U. S. is questioned by some authorities on the grounds that there is no significant incidence of protein malnutrition in this country. It is reasoned that the "average" American consuming an "average" diet has an "average" daily intake well in excess of the Recommended Dietary Allowance of 1 g of protein per day per kg of desirable weight. Consequently, it is held that protein malnutrition is not a public health problem in the U. S. and little value is seen in attempts to improve protein quality.

Needless to say these views are not shared by many nutritionists and medical authorities who are perhaps justifiably suspicious of conclusions based on hypothetical "averages." Certainly it seems very difficult to justify "averaging" the daily protein requirements and intakes of such diverse groups as infants, growing children, pregnant women, old people and invalids together with those of the adult population at large. Where there is great individual or group variation, "averages" can be meaningless or misleading.

TABLE 6

Protein efficiency ratios (PER) of protein breads, with and without lysine supplements, compared with milk solids[1]

Sample	PER
Protein bread	1.87
Protein bread + ¼ % L-lysine monohydrochloride	2.38
Protein bread + ½ % L-lysine monohydrochloride	2.59
Nonfat milk solids	2.54

[1] Unpublished data, Chas. Pfizer & Co., Inc.

This can be illustrated by statistics on average income figures. The average income in the U. S. is approximately $2027 per capita. However, the average income in the state of Mississippi is only $958 per capita. So, too, with protein intake. Although some groups are consuming an average or better than average amount of protein, other groups—and many more individuals—are subsisting on diets supplying a level of protein markedly below the average.

Furthermore, in considering such broad "averages", time factors may be overlooked. Such mutual supplementation as actually occurs takes place only when the supplementary foods are eaten at the same time. Foods eaten at one meal cannot adequately supplement those eaten at another meal even the same day, much less those eaten tomorrow or next week or next month *(14, 22, 25)*. Then, too, protein needs are known to be sporadic, generated by stress situations such as growth, lactation, pregnancy, disease, convalescence. Unfortunately these times of need don't necessarily coincide with optimum protein supply in the diet.

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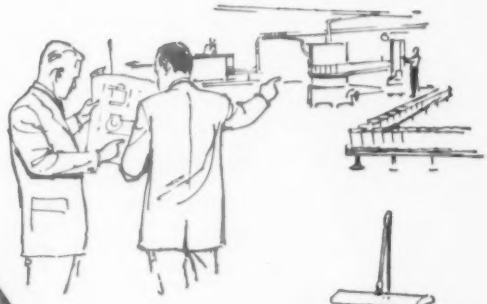

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For example, in a recent nutrition survey conducted in Chicago it was determined that more than 75% of the teenagers interviewed ate a poor breakfast or none at all *(7)*. It was noted that the other meals of the day will not make up for this serious lack of breakfast.

3. *Minimum Daily Requirement.* It has been suggested that the human requirement for lysine is so low that even the poorest diet will supply it *(21)*. If this were true, it would obviously be impossible to make a case for lysine supplementation. Actually there is no recognized minimum daily requirement (MDR) for lysine or any other essential amino acid.

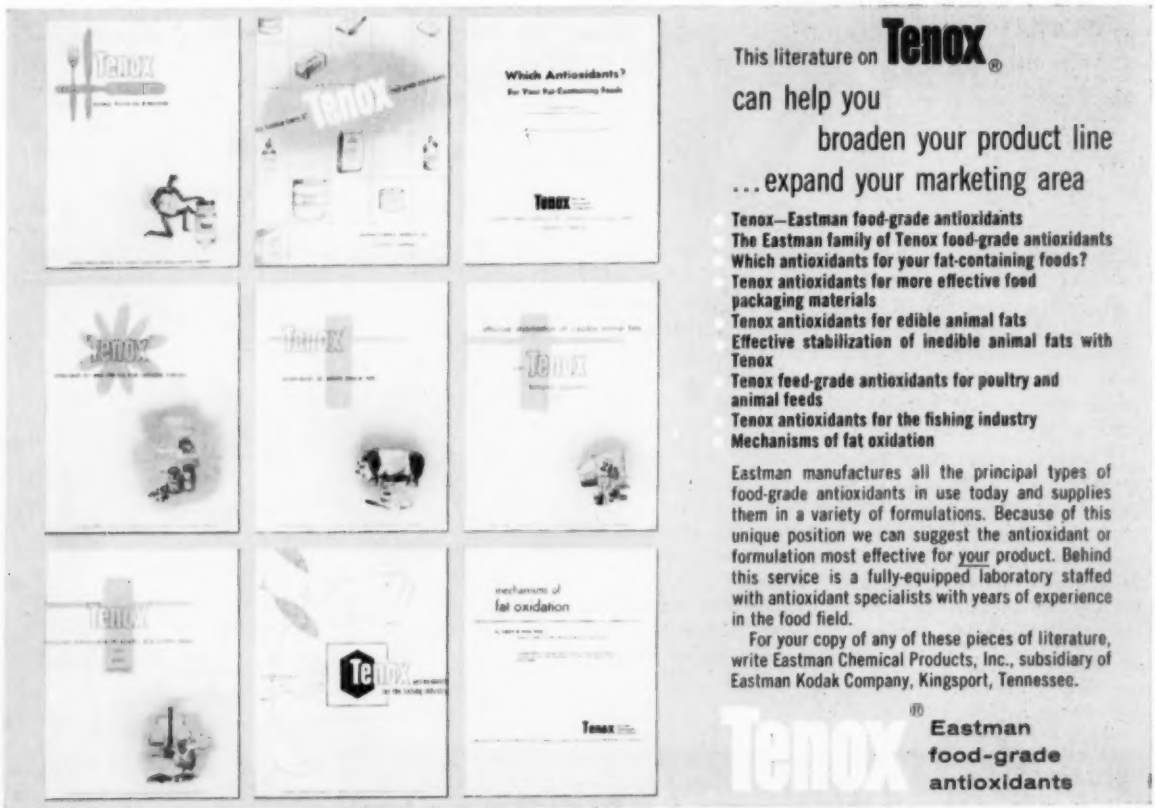
The validity of the MDR concept is fairly well established as regards the micronutrients—the vitamins and minerals which are essentially catalysts. However, amino acids are macronutrients—they are building blocks, the stuff of which living tissue is made. It is by no means clear that the MDR concept is fully valid as applied to macronutrients—or to put it another way, there is probably a bigger difference between minimum and optimum requirements for amino acids than for vitamins. In this regard, Mayer *(32)* stated, "Essentially *minimal* amounts of the latter (vitamins and minerals) must be provided to avoid disease or to insure optimum performance. . . . The situation is quite different in regard to amino acids. While early work stated daily amino acid requirements in terms of a minimum, . . . it has come to be realized that such an approach was erroneous. . . . In other words, when dealing with amino acid requirements, we are dealing with the need for a *pattern* of essential amino acids. . . . " Dr. Rose *(40)* himself states, "A *safe* intake is not to be confused with an optimum intake which undoubtedly is still higher but for which no direct measurement is available." Also, Rose's minimum figures are only the minimum necessary for healthy young males determined in short-term studies and are in no way applicable to the majority of our population *(40, 41)*.

Another indication that the MDR concept is very misleading when applied to protein nutrition is seen in the work of Allison *(6)* who showed that the minimum amounts of various proteins required to maintain nitrogen balance were three to four times higher for well-fed dogs than for starved dogs (Figure 2). Since in the U. S. we are interested in optimal rather than minimal nutrition, policies based on minimum values seem out of place.

4. *Amino Acid Imbalance.* When supplementation with lysine first became a practical possibility, it was objected to on the grounds that an excess of a single amino acid could cause harmful effects *(18)*. It had, of course, been demonstrated that such imbalances can be experimentally produced in rats by adding excess amounts of certain amino acids to low protein diets. However, Harris and Burress *(24)* showed that no imbalances resulted from feeding five- to eightfold excesses of lysine to rats on diets containing both 8% and 15% of wheat protein. Even the excessive levels of lysine markedly improved the PER's of these diets.

Indirect evidence discounting the possibility of harmful effects from administration of lysine is seen in the numerous clinical trials *(1–5, 12, 29, 30, 35, 44, 45)* where lysine has been given as a pharmaceutical supplement. Dosages have ranged from 250 mg daily for newborn infants to 1200 mg daily in three divided doses for elderly adults, and included one trial where one gram daily was given to children in a single dose. There is no record of a single adverse effect, and in the vast majority of cases the results were highly beneficial.

For example, in poorly growing infants *(3)* appetites and growth rates were significantly improved, hemoglobin and plasma protein levels were raised. In children in confirmed growth failure *(29)*, 78% resumed normal growth when given lysine supplements. In the elderly, the most significant clinical finding was the elevation of hemoglobin levels, although there was great subjective improvement *(35)*. In a large group of



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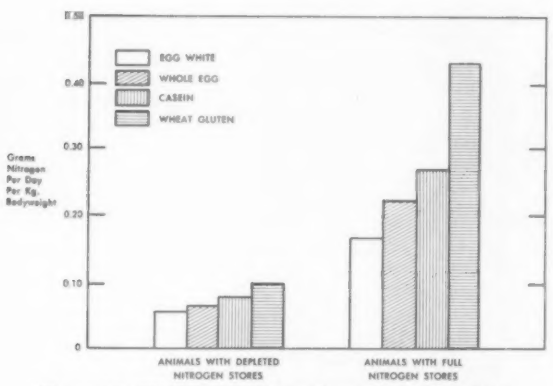

Figure 2.* Minimum protein requirements of adult dogs.

* Adapted from Allison, *Physiol. Revs.*, 35, 664 (1955).

pregnant women representing a good cross-section of a private obstetric practice *(44)*, there was great subjective improvement in the treated group, supported by higher hemoglobin levels, no pre-eclampsia and superior postpartum convalescence.

Improved hemoglobin levels were frequently observed in these studies. It appears more than coincidental that hemoglobin is largely protein in character and contains more lysine than any other body protein *(35)*.

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Although lysine can also upgrade the protein of white bread, flour, and macaroni products, composition of these products is governed by FDA Standards of Identity. Hence, lysine may not be added to any standardized food unless the standard is amended, or an experimental permit is obtained. At present there is a petition before the FDA requesting the inclusion of L-lysine as an optional ingredient in the standards for white bread and related products.

SUMMARY

Protein malnutrition varies from frank deficiency through debilitating insufficiency to suboptimal intake. There may well be many persons with a suboptimal intake even in well-nourished countries like the U. S.—especially groups under nutritional stress as in growth, pregnancy, lactation, convalescence, disease.

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Arguments objecting to lysine supplementation have been discussed, including mutual supplementation, reasoning from average values, minimum daily requirements and amino acid imbalance.

Lysine supplementation of appropriate foods is proposed as a step toward optimal nutrition.

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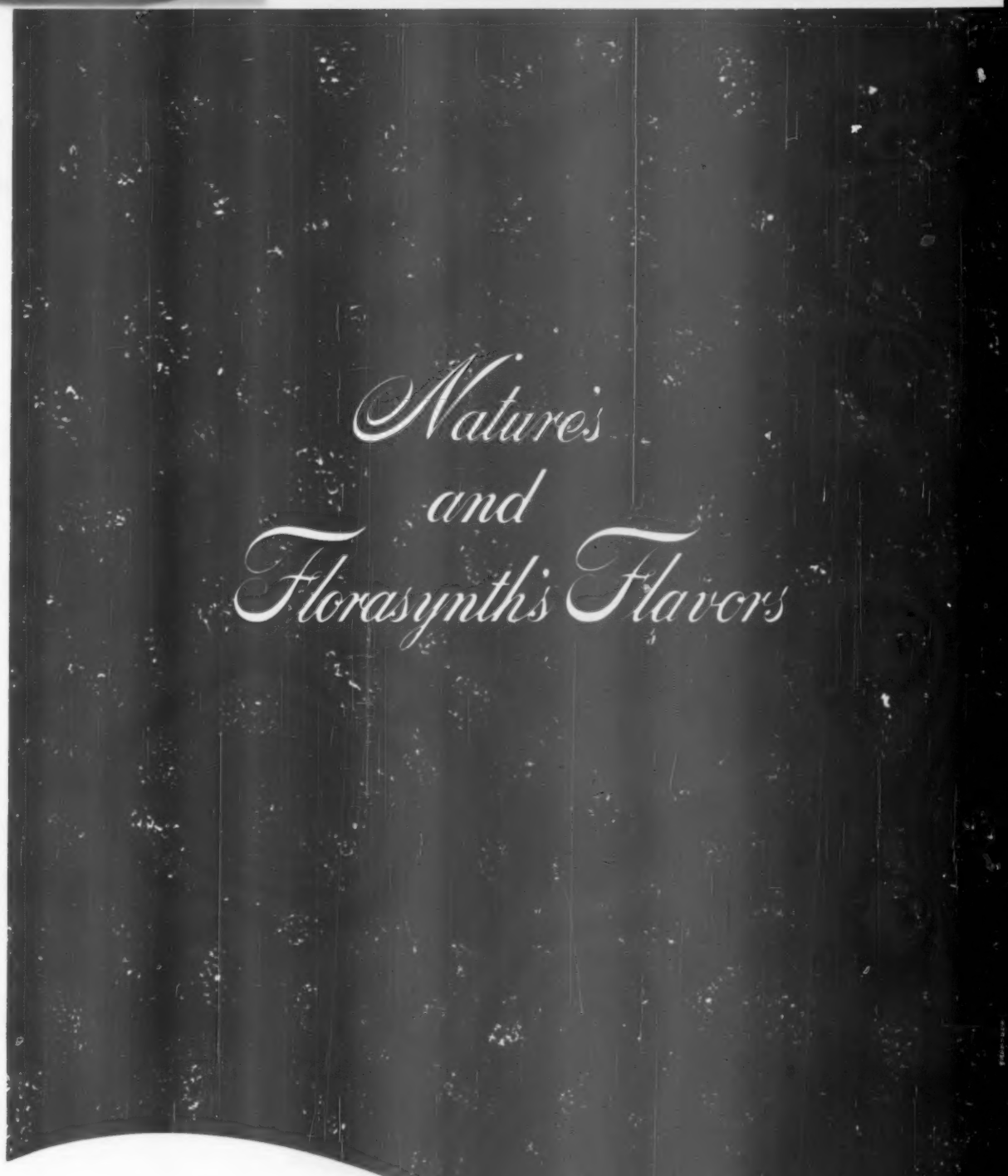

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Time-Temperature Tolerance of Frozen Foods. XXI.

Frozen Peas

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(Manuscript received August 13, 1959)

EXPERIMENTS were carried out with four varieties of frozen peas packed in retail packages in eight processing plants in four major growing areas during the seasons of 1952 to 1957. Changes in color, flavor, chlorophyll, reduced ascorbic acid content, and reflectance data obtained by the Hunter Color and Color-Difference Meter (HCM) were determined as a function of temperature in the range of −10° to +40° F. Effects of regular and irregular fluctuations in product temperature were measured and the question whether the order of occurrence of different temperatures has any influence was investigated.

METHODS AND MATERIALS

Procedures up to the time the peas reached the Laboratory were the same as those reported for frozen green beans by Dietrich *et al (3)*. The methods of determining conversion of chlorophyll to pheophytin (expressed as per cent retention of chlorophyll) and reduced ascorbic acid (mg/100 g), and the procedures for reflectance measurements were described by Dietrich *(1)* and Dietrich *et al (2, 3)*. Information on source and handling of the lots and on objective measurements of initial quality are summarized in Table 1. Peroxidase tests by the method of Masure and Campbell *(7)* showed that all lots were adequately blanched. "Initial" or "control" samples were held at −20° or −30° F as standards for comparison. Objective measurements for the present study and earlier results by Ward and Boggs *(10)* showed that quality changed little or not at all under these conditions.

Peas for flavor evaluation were cooked by boiling for 5 min in one-third their weight of water. Lot 4 peas, which were tough, were boiled for 10 min. Trained judges ranked flavor of 4 cooked samples or color of 5 or more thawed, uncooked samples per session. Rank 1 indicated least off-flavor or off-color. Samples of a test consisted of a labeled and coded control and several coded samples which had been held for varying periods at a single temperature; all samples of a test were from the same lot of peas.

For steady and regularly fluctuating temperature treatments, judges' results were expressed as the elapsed time in days before difference from control was detected. The control was paired with samples held for successive times (control—120 days, control—240 days, and so on) until 75% or more judges rated a sample different from the control. The holding time for this sample was called the first detectable difference. In the sequence-of-temperatures and the irregular-temperature studies, judges' rankings were interpreted from analysis of variance and the Duncan test *(4)*. Sources of variation were treatment, treatment-by-judge interaction, and residual. The interaction was never significant and residual mean square was used to test treatments.

RESULTS AND DISCUSSION

Steady temperatures. Parts A and B of Figure 1 show the time elapsed before the first detectable differences in color and flavor of lots 1 to 6 were observed. The average times at 0°, 5°, 10°, 15°, 20° and 25° F when color first changed were 202, 98, 48, 23, 11 and 5 days and the times when flavor changed were 305, 166, 90, 49, 27 and 14 days, respectively. At 10° and 15° F, it took approximately twice as long for off-

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TABLE 1

Source and handling of the various lots of peas and their initial objective measurements

Lot No	Variety[1]	Harvest year	Growing area[2]	Blanch[3]		Field-run tenderometer reading	Alcohol insoluble solids	Approx delay[4]	Initial measurements		
				Temp	Time				Chlorophyll	HCM "a"	Ascorbic acid
				°F	min		%	hr	% retention		mg/100 g
1	DGP	1952	O	200–4	1.5	96	11.4	0	96.9	19.8	21.4
2	DGP	1953	O	195–8	1.5	87	10.8	0	96.8	19.5	25.0
3	P	1954	M	208–9	1.0	100	11.8	3.5	96.8	19.3	22.3
4	L	1954	ES	208–10	1.8	....	12.6	2–3	93.5	18.2	14.7
5	L	1955	M	208	1.0	84	11.0	2–3	97.4	19.8	18.3
6	VF	1955	ES	210	1.5	98	11.6	1.5–2	95.0	19.6	19.3
7	DGP	1956	W	210	1.5	104	11.2	2.5	93.8	18.6	18.4
8	DGP	1956	W	200–4	1.5	88	10.5	0	97.0	19.8	19.1
9	DGP	1956	W	205–8	1.5	105	11.8	3	95.2	18.9	18.2
10	DGP	1956	W	204	1.2	111	13.2	0	97.2	18.9	24.5
11	DGP	1956	W	205–8	1.5	....	11.5	0	97.3	19.3	13.4
12	DGP	1956	ES	....	....	....	12.3	....	92.5	18.4	18.7
13	DGP	1957	O	....	....	....	10.4	....	95.4	19.2	20.7
14	DGP	1957	O	....	....	....	16.1	....	97.1	19.7	16.9

[1] DGP is Dark Green Perfection; P, Pluperfect; L, Laxton; VF, Victory Freezer.
[2] O is Oregon; M, Minnesota; W, Washington; ES, Eastern Seaboard.
[3] Lot 2 was blanched in steam; al others, in water.
[4] Approximate hours of delay between vining and processing.

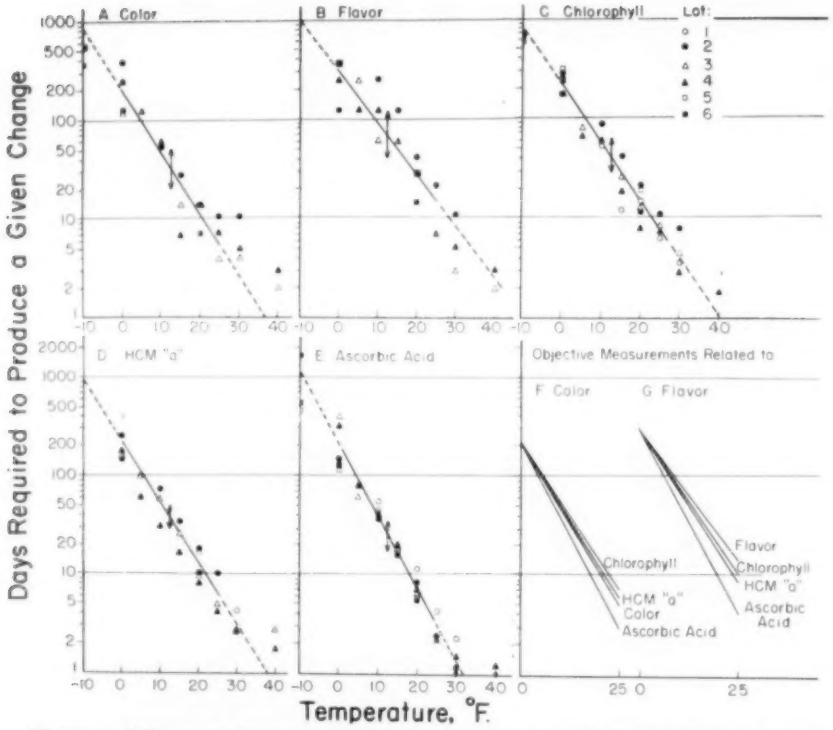

Figure 1. Influence of temperature on the time required to produce the following changes in frozen peas.

A and B. Time elapsed before color and flavor differences were detected by judges (75% of judgments).

C, D, and E. Time that resulted in a given decrease in objective measurements. The amount of the decrease is the average amount that occurred during the time required to produce detectable color differences at 0° F. Chlorophyll, 1.78%; HCM "a", 0.37; Ascorbic acid, 1.50 mg/100 g.

F. Comparison of regression lines of A, C, D, and E.

G. Regression lines similar to F, but the amounts of the decreases in objective measurements correspond to the time to produce a detectable flavor difference at 0° F. Chlorophyll, 2.61%; HCM "a", 0.56; Ascorbic acid, 2.30 mg/100 g.

Solid lines best fit (method of least squares) all points between 0° and 25° F. Broken lines are extrapolations. Arrows show the magnitude of 2 standard errors of estimate.

flavor to develop as for off-color to appear. This ratio did not hold exactly at higher and lower temperatures.

Parts C, D, and E of Figure 1 show the times which resulted in decreases of 1.78 in per cent retention of chlorophyll, 0.37 in HCM "a" reading, and 1.50 in mg/100 g of ascorbic acid, respectively. These decreases are the average amounts that occurred in lots 1 to 6 during 202 days at 0° F; 202 days at 0° F was the average time which resulted in detectable color change in the 6 lots. The chlorophyll and HCM "a" data (parts C and D of Figure 1) show that deterioration rates approximately doubled for each 5° F increase in temperature between 0° and 25° F. Ascorbic acid rates (part E) more than doubled under the same conditions.

When the 0° to 25° F calculated lines in parts A through E of the figure were extrapolated to 30° F, all of the points except those for color (part A) fitted the lines rather well. This was not true for 40° F points. Although, usually, deterioration was faster at 40° than at 30° F, it was not as much faster as would be expected from the 0° to 25° F results. Flavor changes (Part B) were an exception; they followed the 0° to 30° F pattern. In most instances, then, an approximately two-fold increase in deterioration rate per 5° F held up to 30° F, but not between 30° and 40° F.

Data for several lots of peas held at −10° F do not appear in Figure 1. In the case of objective measurements, no change occurred in these lots until the final period tested, and, therefore, rates of deterioration were not calculated. As regards flavor results, the differences between controls and peas held for 2 years were not quite significant at the level required in the study. The data showed, however, that −10° F provided considerably more quality protection than did 0° F.

Figure 1F assembles the regression lines from parts A, C, D, and E of the figure. Part G is the same kind of graph as Part F except that the fixed decreases in objective measurements correspond to the first flavor difference at 0° F instead of the first color difference. Student's "t" test showed that none of the slope of lines for objective measurements in Figure 1F was significantly different from the slope of the color line when variability of the commercial material was con-

sidered in the significance tests. Thus, all of these objective measurements were closely associated with color deterioration.

As regards the relation of the objective measurements to *flavor* deterioration (Part G of Figure 1), the difference between slopes of ascorbic acid and flavor lines was highly significant; this was not true, however, for comparison of the other objective measurements with flavor results. There was no reason to expect chlorophyll and HCM "a" measurements to correlate with *flavor*, except to the extent that color and flavor themselves were associated. It has been mentioned that there was considerable, but not complete agreement of color and flavor results.

Lots 7 to 14 were studied at 20° F only; they provided a check on the first 6 lots. The general agreement of the two groups (Table 2) indicates that fairly representative sampling of commercial packs was obtained.

The amount of variation in rates of deterioration of the various lots of peas was substantial. For example, the range of chlorophyll deterioration rates for the 14 lots held at 20° F was almost as large as the range for a 10° F spread in temperature for one typical lot.

The relations between the objective measurements and color, shown in Figure 1, were limited to the points of first detectable differences, that is, to peas held for relatively short periods. In order to observe any relation of chlorophyll and HCM "a" to color judgments over a wider range of times, results for all adjoining times (control—2 days, 2 days—4 days, and so on) were summarized. Data for all 14 lots held at each steady temperature up to and including 25° F and at each fluctuating temperature were included in the summary. Table 3 shows that chlorophyll and HCM "a" differences were useful indices of color change over a wide range of deterioration levels as well as for peas held just long enough to be judged different from controls.

Industry panels. Panels of quality control men, buyers, and other industry representatives who are professionally concerned with quality of frozen vegetables scored color of 6 lots of peas which had been held for varying times at 20° F. Score 1 indicated high quality; score 2, acceptable but not high quality; and score 3, sufficiently poor to cause consumer

TABLE 2

Comparison of times required to produce given changes in Lots 1 to 6 and in Lots 7 to 14 held at 20° F

	Days of storage to a decrease of			Days of storage to first detectable difference	
	1.78 in % retention of chlorophyll	0.37 in HCM "a"	1.50 in mg/100 g of ascorbic acid	Color	Flavor
Lots 1–6					
Average days[1]	14	12	7	11	27
Range of days	8–21	8–18	5–11	7–14	14–42
Lots 7–14					
Average days[2]	18	12	9	6	33
Range of days	10–34	9–20	5–16	4–14	14–42

[1] Read from regression lines in Figure 1.
[2] Arithmetic mean.

TABLE 3

Chlorophyll and HCM "a" differences required for 75 to 94% of judges to distinguish between colors of two samples

Objective data	Samples compared			
	Control and stored sample which gave first detectable difference		All adjoining storage periods	
	Mean	Standard deviation	Mean	Standard deviation
Chlorophyll difference	1.5	0.8	1.6	0.9
HCM "a" difference	0.4	0.2	0.4	0.2

complaint. Results for the different lots are not strictly comparable because one panel scored Lot 1, a different panel scored Lots 2, 3, and 4, a third panel scored Lots 5 and 6, and each lot was handled as an independent study.

Figure 2 A shows that the time when the different lots reached the stage called "acceptable, but not high quality" varied from approximately 1 to 2 months. (Lot 4 was not "high quality" at the start.) Figure 2 B shows a close relationship between scores and chlorophyll content of any given lot of peas; but at any given chlorophyll level, Lots 2 and 3 usually re-

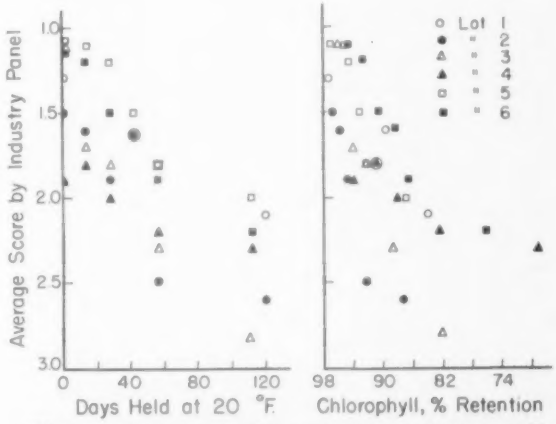

Figure 2. Scores by industry panels for peas held at 20° F: A. Effect of time held at 20° F. B. Relation to chlorophyll level. (Score 1—high quality; 2—acceptable, but not high quality; 3—sufficiently poor to cause consumer complaint).

ceived somewhat poorer ratings than Lots 1, 5 and 6; Lot 4, whose control was not "high quality", showed fairly large chlorophyll changes with only small score changes. All of the lots were rated as "acceptable, but not high quality" or close to this stage, when chlorophyll had decreased to 86% retention and Lots 2, 3 and 4 had reached this stage with considerably higher chlorophyll levels. HCM "a" correlated with scores somewhat better than did chlorophyll, but ascorbic acid content and scores were not closely associated.

Varied sequence of two steady temperatures. The sequence of exposing peas to two different steady temperatures was varied in tests with Lot 1 to determine whether an early abuse might make peas more sus-

septible to deterioration at a later time. An example of the sequences in one test follows: (a) 4 months at 10° F followed by 4 months at 0° F, (b) 4 months at 0° F followed by 4 months at 10° F, and (c) 2 months at 10° F followed by 4 months at 0° F, then the other 2 months at 10° F. This sequence plan was applied to 5 combinations of 2 temperatures. Analysis of variance of the data for each of the 3 objective and 2 subjective measurements showed that sequence of temperatures did not affect deterioration; the F ratio obtained from each of the 5 sets of data was always 0.8 or less.

Fluctuating temperatures. Regular and irregular patterns of fluctuating temperatures were studied to determine the amounts of deterioration in the various patterns, and to determine whether fluctuation *per se* affected deterioration.

The temperatures of the regular, 24-hr, sine-wave cycles were −5° to 5°, − 10° to 10°, and 0° to 20° F. The effective temperatures of the cycles were calculated from steady temperature rates of change by the formula of Schwimmer *et al (8)*. Then these calculated effective temperatures were compared with the values obtained for peas actually held under the fluctuating temperatures.

The observed and calculated effective temperatures, based on either chlorophyll or ascorbic acid measurements (Table 4), agreed rather well. Although the individual pairs of observed and calculated HCM "a" values were not significantly different, the observed values were consistently slightly higher than the calculated values. The flavor results agreed with objective data rather well.

The regular, short-cycle fluctuating temperatures just discussed are not likely to be encountered in commercial distribution of frozen peas. Therefore, 3 patterns which simulate handling conditions of varying severity were investigated. The patterns are illustrated with chlorophyll data for Lot 3 in Figure 3. The coordinate system of the figure was constructed according to the procedure of Van Arsdel and Guadagni *(9)*. The chlorophyll results obtained from

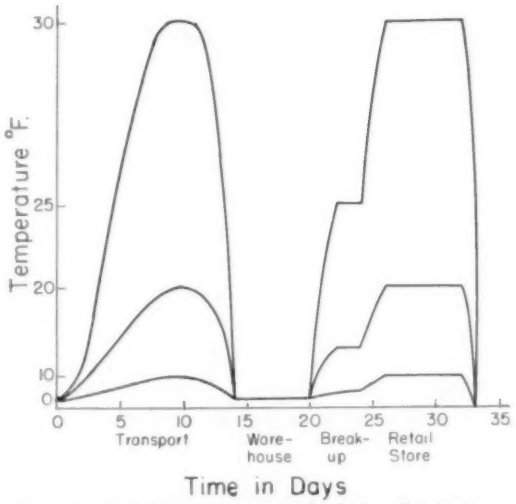

Figure 3. Temperature patterns simulating distribution conditions graphed on a scale with temperature spaced in proportion to the rates of change in chlorophyll at steady temperatures. (Lot 3).

each lot of peas are summarized in Table 5, which shows that calculated and observed values agreed rather closely in most instances. Similar results based on HCM "a" and ascorbic acid (not illustrated) agreed equally well.

Considering all of the data for regular and irregular fluctuating temperatures, the present study, like previous reports in the time-temperature tolerance series *(3, 5, 9)* shows that fluctuation *per se* had little or no effect on deterioration.

The last column in Table 5 shows the days at 0° F required to cause the same deterioration as occurred in the various irregular patterns. Equivalent times at 0° F for the 30°, 20° and 10° F patterns were of the order, 2.5 months, 1 year and 2 years, respectively. It is clear that high quality obtained by selection of excellent raw material and by excellent processing

TABLE 4

Observed and calculated steady temperatures that correspond to 24-hour, sine-wave cycles of fluctuating temperatures[1]

Measurement	Lot	Effective steady temperature					
		−5° to 5° F[2]		−10° to 10° F[2]		0° to 20° F[2]	
		Observed	Calculated[3]	Observed	Calculated[3]	Observed	Calculated[3]
		°F	°F	°F	°F	°F	°F
Chlorophyll	1			2.0	3.3		
Chlorophyll	2	1.0	0.8	1.5	3.0	13.7	12.9
Chlorophyll	3	1.5	0.9			13.0	13.0
Chlorophyll	4	1.5	0.8			13.5	13.0
Ascorbic Acid	2	−1.5	1.0	4.0	3.6	14.2	13.5
Ascorbic Acid	3	1.2	1.2			12.0	14.1
Ascorbic Acid	4	3.4	1.2			12.4	14.0
HCM "a"	2	2.5	0.9	3.5	3.0	14.0	13.0
HCM "a"	3	3.0	1.0			14.5	13.2
HCM "a"	4	3.5	1.0			15.5	13.3
Flavor	2	3.5		3.4		13.0	
Flavor	3	2.2				12.5	
Flavor	4	2.0				12.2	

[1] If fluctuation *per se* had no effect, the observed and calculated temperatures would be the same, within experimental error.
[2] One-day cycles except Lots 3 and 4 at 0° to 20° F which were three-day cycles.
[3] Calculated by the formula of Schwimmer *et al (8)*.

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New Data on Aluminum Foil Packaging for Frozen Foods

Report No. 25 of a Series by Reynolds Metals Co.

The advantages of aluminum foil packaging in maintaining the temperature of frozen foods have long been recognized. Phases of the subject were presented in two previous reports of this Series. Report No. 9 dealt with packaged ice cream, with and without aluminum foil overwraps, in display freezers. In the vulnerable upper layers, temperatures of the foil-wrapped product averaged 9° less than for the ice cream without foil. Report No. 17 compared speed of freezing and extent of dehydration in variously packaged green peas in an air-circulated freezing compartment at −10°F. Results showed foil-wrapped peas reaching 0°F. in about half the time required for non-foil-wrapped peas—and dehydration, as measured by cavity ice, significantly less.

Added Importance for Foil

Currently, aluminum foil packaging for frozen foods takes on added importance in view of the recommendations of the Association of Food and Drug Officials of the United States to establish a national maximum-temperature code.

It is in the light of this development that the Packaging Research Division of Reynolds Metals Company sought — and here presents — additional data specifically on the moderation of temperature rise in the contents of open display freezers.

Tests Use Frozen Vegetables

The new research compared packages of frozen whole broccoli overwrapped with printed Reyseal (Reynolds foil-wax-tissue heat sealing lamination), and the same packages overwrapped with printed wax paper (33 lbs. per ream coated bright finished paper overwaxed with approximately 14 lbs. of wax per ream). Thermocouple leads were introduced to the center of the test packages, then the packages were stacked in an open display freezer—stacked six high in center front position with other packages at the sides and behind. Thermocouple readings were recorded at the peak of the defrost cycle (once in 24 hours) and after temperature had dropped to equilibrium conditions. The freezer was set to maintain −20°F. As the tables show, the top foil packages averaged 12.4° colder during the freezing cycle and 8.6° colder at the peak of the defrost cycle. For the lower packages in the stacks, the foil packages averaged approximately 2.5° colder during both cycles.

Analyses of the Tables

Variance analyses of the test data show that the average differences in temperatures between foil-wrapped and wax-paper-wrapped packages are highly significant statistically. There is less than 1 chance in 100 of such differences occurring by chance.

Analysis also shows that all or nearly all of the observed differences are attributable particularly to the top packages, which are exposed to the maximum effect of external (radiant) heat sources.

Two-Way Effectiveness

These results tend further to confirm that both the radiant heat reflectivity and the high thermal conductivity of aluminum foil are involved in its effectiveness in moderating temperature rise. Less radiant heat reaches the contents when packages are foil-wrapped. And absorbed heat is more rapidly conducted by foil — to be dissipated in the lower part of the stack by contact with refrigerated air and colder surfaces.

Now More than Ever

The AFDOUS "zero temperature" code proposal re-emphasizes the importance of temperature reduction and therefore the value of aluminum foil protection for frozen foods. The advantages of this protection include both maintenance of product quality through temperature rise moderation and also economies in freezer cabinet operation. For further information, please call your local Reynolds representative. Or write to **Reynolds Metals Company**, Richmond 18, Virginia.

Package Temperatures During Defrost Cycle
Average of five replicate cycle temperatures (°F.)

Foil Overwrap	Advantage For Foil	Wax Paper Overwrap
+16.0	8.6	+24.6
+ 6.4	4.4	+10.8
+ 5.6	4.0	+ 9.6
+ 5.2	0.4	+ 5.6
+ 0.6	1.4	+ 2.0
+ 7.0	2.2	+ 9.2
Average + 6.8	3.5	+10.3

Average difference bottom 5 packages = 2.5° F.

Package Temperatures During Freezing Cycle
Average of four replicate cycle temperatures (°F.)

Foil Overwrap	Advantage For Foil	Wax Paper Overwrap
−12.2	12.4	+ 0.2
−12.2	2.4	− 9.8
−12.8	2.8	−10.0
−10.8	0.8	−10.0
−15.2	3.2	−12.0
−17.2	3.0	−14.5
Average −13.5	4.1	− 9.4

Average difference bottom 5 packages = 2.4° F.

See these Reynolds shows on ABC-TV Network: "BOURBON STREET BEAT" and James Michener's "ADVENTURES IN PARADISE" Monday Nights.

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TABLE 5

Influence on chlorophyll of irregular temperature patterns which simulate distribution conditions[1]

Lot	Maximum temp of pattern	Initial Chloro-phyll	Chlorophyll content		Chlorophyll loss as equivalent time at 0° F
			Observed[2]	Calculated[2]	
	°F	% retention	% retention	% retention	days
3	10	96.8	96.3	96.2	58
3	20	96.8	94.2	94.4	298
3	30	96.8	90.1	88.9	780
4	10	93.5	92.4	92.7	98
4	20	93.5	90.3	90.6	290
4	30	93.5	85.2	83.2	777
5	20	97.4	94.0	95.4	513
5	20[3]	97.4	93.5	93.8	670
5	20[4]	97.4	93.0	94.0	593
6	20	95.0	91.0	92.1	367
6	20[3]	95.0	88.8	89.5	604
6	20[4]	95.0	88.5	89.9	575

[1] See times and temperatures of patterns in Figure 3; all data apply to 33-day patterns.

[2] If fluctuations *per se* had no effect, the observed and calculated chlorophyll values would agree within experimental error.

[3] Eight months at 0° F (simulating warehouse holding) preceding all of the irregular patterns.

[4] Eight months at 0° F following the first 14 days of the pattern. By mistake, the maximum temperature during the first 14 days reached 18° F only, instead of 20° F.

and warehousing procedures would be lost in the final month before consumers receive frozen peas if product temperature increased much above 10° F.

SUMMARY

Retail packs of frozen peas from a broad sampling of commercial operations were used in the study. Changes in color, flavor, chlorophyll, ascorbic acid, and reflectance data obtained with the Hunter Color and Color-Difference Meter (HCM) were determined as a function of temperature in the range of −10° to +40° F. Also, the effects of several regular and irregular fluctuations in product temperature were investigated.

Off-color was detected by trained judges in frozen peas that had been held for approximately 7 months at 0° F and off-flavor, after approximately 10 months at the same temperature. All measurements, except ascorbic acid, showed that deterioration rates approximately doubled for each 5° F increase in temperature between 0° and 25° F. Ascorbic acid loss rates more than doubled under the same conditions.

The two-fold change in deterioration rates per 5° F applied up to 30° F in the case of chlorophyll, HCM "a", and flavor data, but not to color data. Much less than the two-fold change per 5° F occurred between 30° and 40° F, except for flavor which followed the 0° to 30° F pattern.

Chlorophyll and HCM "a" *differences* for two samples of the same lot of peas were good indices of color deterioration and reasonably good indices of flavor deterioration.

Fourteen lots of peas held at 20° F varied almost four-fold in their rates of chlorophyll loss.

Industry panels found that color of all 6 lots of peas they evaluated had reached a stage which they characterized as "acceptable, but not high quality" in one or two months at 20° F. Chlorophyll and HCM "a" results correlated reasonably well with industry panel scores; ascorbic acid content of the peas and panel scores were not closely associated when all lots of peas were considered.

Changing the order of occurrence of two different steady temperatures did not significantly affect deterioration of frozen peas.

Fluctuation of temperature *per se* had little or no effect on deterioration of peas held under regular, 24-hour, sine-wave cycles varying from −5° to 5°, −10° to 10°, and 0° to 20° F and under 3 slower, irregular temperature patterns with maximum temperatures of 10°, 20° and 30° F.

Acknowledgments

The writers thank the Refrigeration Research Foundation for providing a substantial portion of the frozen peas and personnel of the freezing plants where peas were procured for their cooperation and aid. The assistance of Dr. H. K. Burr with mathematical problems was invaluable. The project could not have been carried out without the help of a large group of analysts, laboratory aides, and tasters whose names do not appear in this publication.

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A Method for the Rapid Tenderization of Beef Carcasses[a, b]

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In a previous report on the aging of beef steaks at elevated temperatures *(4)*, results showed that steaks from chilled carcasses could be tenderized by holding them at 110° F for 24 hours. The extent of microbial growth was found to be less severe at this temperature than at 90° F and could be controlled by the injection of antibiotics into the round prior to cutting into steaks. Steaks were used in the previous work to reduce the experimental error with respect to variations in tenderness within and between animals and to facilitate the control of the aging temperatures.

In the present work the results of the previous study were applied in the aging of five beef carcasses immediately post-mortem in a manner which would more nearly approach the probable commercial use of the accelerated aging procedure. Preservation during aging was provided by an ante-mortem injection of oxytetracycline. The limited time-high temperature schedule was compared to a more conventional aging procedure of holding for two weeks at 35° F. Because of the limited number of carcasses, four muscles in each carcass were used to determine the effectiveness of the aging procedures. The preliminary results reported in this paper indicate that beef in the carcass can be tenderized in 24 hours at 110° F. A more thorough investigation with a greater number of carcasses is required before completely dependable conclusions can be drawn regarding the accelerated aging procedure.

EXPERIMENTAL

The animals for this study weighed 900 to 1,000 lb and were selected on the basis of having a predicted carcass grade of U. S. Good. One to 3 hr prior to slaughter each animal was given an injection of oxytetracycline (Biostat).[d] Blood and liver samples were taken at the time of the slaughter for antibiotic assay. Muscle samples were also assayed after aging. Following the dressing procedure, the warm carcass was quartered and taken to the laboratory for aging.

Antibiotic administration and microbial control. Animal number one was injected into the abdominal cavity immediately posterior to the 13th rib with 10 g of oxytetracycline in 100 ml of citric acid and water. Because of the crouched position of the animal at time of injection an undetermined amount of the antibiotic solution lodged in the muscle tissue and limited the distribution of the antibiotic in the remainder of the carcass.

Other research *(3)* had shown that, though the absorption was slower, a satisfactory distribution of antibiotic could be achieved by an ante-mortem injection in the tail; to avoid further difficulties in administering the antibiotic this procedure was used. The quantities of oxytetracycline (OTC) indicated in Table 1 were put into 40–50 ml of solution and injected intramuscularly along the middle one-third of the tail. The transport of the OTC from the site of injection is indicated by the assays for the antibiotic in the blood and liver. Tissue levels were considerably lower than those of the blood and liver but were probably sufficient to control microbial growth during subsequent aging.

TABLE 1

The ante-mortem injection of oxytetracycline and its retention in the liver, blood, muscle and tissue

Animal	Quantity of OTC	Site of injection	Time to slaughter	Oxytetracycline (ppm)[1]			
				Rib eye		Liver at slaughter	Blood at slaughter
				14 days 35° F	1 day 110° F		
1	10 g	abdominal cavity	2 hr	0.4		3.8	1.4
2	8 g	tail	3 hr	0.6	0.9	7.4	1.8
3	8 g	tail	3 hr	1.6	1.5	9.4	3.3
4	5 g	tail	2 hr	0.5	0.3	3.8	0.6
5	8 g	tail	3 hr	0.6	0.4	5.7	....

[1] Assays performed by Chas. Pfizer and Company, Inc. Each value represented the average of 5 to 10 assays per sample.

Procedures for determining bacterial counts have been presented previously *(4)*. With the exception of the second carcass the counts of anaerobic bacteria in samples taken from the rib section following aging at 110° F were 10,000 per g or less. In samples from rounds aged at 110° F anaerobic counts did not exceed 80,000 per g with the exception of the second carcass. The extensive anaerobic growth in samples from this carcass did not permit a count to be made at the dilution employed. Water extracts of the same muscles from the carcass were without effect when injected interperitoneally into mice, thus indicating no botulinum toxin was found.

The low order of anaerobic bacterial growth in the remaining carcasses suggests that the high plate counts on samples from the second carcass resulted from sampling methods which permitted contamination and that the high counts did not result from bacterial growth during the aging procedure. However, evidence from this assumption was not sufficient to allow the steaks from this carcass to be served to the taste panel and in this instance only the shear test was used to evaluate the effect of aging on tenderness.

Aging procedures. The right or left hind quarter and the seven rib cut of each carcass was aged at 110° F for 24 hr and the paired quarter and rib were aged for 2 weeks at 35° F.

[a] Journal Paper No. 196, American Meat Institute Foundation.

[b] This paper is a report of work done under contract with the U. S. Department of Agriculture and authorized under the Research and Marketing Act of 1946. The contract was supervised by the Eastern Utilization Research and Development Division of the Agricultural Research Service.

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[d] Supplied by Chas. Pfizer and Company, Inc.

Two to 3 hr elapsed between time of slaughter and placing the cuts or quarters under the desired aging or chilling conditions. During this time the internal temperature of the rib sections was reduced to approximately 90° F. For this reason the aging room was maintained at 120° F until the internal temperature of the rib approached 110° F. The holding temperature was then reduced to 110° F for the remainder of the 24 hr aging period. Following aging, the cuts were moved to a 20° F chill room for a 15 hr period. The quarters and ribs which were to be aged at 35° F were chilled at 20° F for a 15-hr period and then maintained at 35° F for the remainder of the 14-day aging period. Steaks were removed from the short loin of the side aged at 110° F and compared with similarly located steaks from the remaining side removed after 48 hr chilling.

Sampling procedures. The *semimembranosus, semitendinosus* and the *biceps femoris* of the round and the *longissimus dorsi* of the rib of each carcass were used to compare the effectiveness of the two tenderization procedures.

To determine the extent of tenderization by the high temperature schedule, unaged steaks, removed after chilling from the short loin of the side which was to be aged at 35° F, were compared with the steaks from the side which had undergone aging at 110° F.

In all comparisons similar anatomical locations were chosen in the right and left sides. From these known locations 4 steaks, ¾ in thick, were removed serially. The steaks were broiled according to procedures described previously *(2)*. Either 2 or 4 samples representing the 2 aging treatments were served to a taste panel of 8 members at each judging session. Each judge was asked to score the steaks on a 10-point scale for initial tenderness and for residue and to comment regarding the flavor of the samples. Portions of steaks not used by the taste panel were used to determine shear strength on the Warner Bratzler shear machine. Five to 7 cores one-half inch in diameter were removed from the remaining portion of each steak and brought to 45° F prior to shearing. One shear was performed on each core. In a few instances the steaks were not large enough to provide sufficient samples for shearing.

RESULTS AND DISCUSSION

Preservation during aging. The limited number of carcasses included in the study does not permit conclusions regarding the adequacy of the procedures used for restricting bacterial growth during aging at 110° F. It is significant, however, that anaerobic bacterial counts were at a low level in samples from 4 of the 5 carcasses, particularly the last two for which maximum precautions were taken to avoid contamination during sampling. The data suggest that 0.5 to 1.0 ppm of the broad spectrum antibiotic in muscle tissue is sufficient to control bacterial growth during a 24-hr aging period at 110° F.

Post-slaughter changes during aging. The temperature during aging and chilling was recorded for the round and rib eye muscles. A similar pattern was found for all carcasses. The temperature curve for carcass number three is shown in Figure 1. Under more suitable conditions the aging room would be in close proximity to the dressing operation and the reduction in temperature noted for the rib section at 3 hr could be avoided. The internal temperature of the rounds at the beginning of aging was usually between 103° F and 105° F rising to a maximum of approximately 108° F after 9 hours of high temperature processing. Processing the first carcass at 110° F and 80 ± 2% relative humidity resulted in severe drying of the exposed lean tissues. In aging the remaining four carcasses a relative humidity of 85–90% was found to be satisfactory for maintaining carcass appearance and was sufficiently low to restrict mold growth.

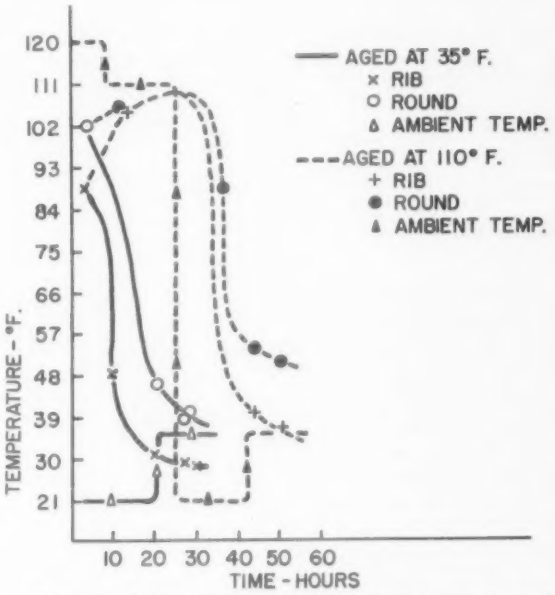

Figure 1. Aging temperature and internal temperature of beef rounds and ribs aged at 35° F and 110° F.

During aging, samples were removed periodically for analysis making it difficult to obtain precise data regarding shrinkage. When corrected for sampling, the average weight loss for the rib sections aged at 110° F and 35° F were 3.9 and 4.4%, respectively. The corresponding weight losses for the hindquarters were 2.2 and 2.0%. Deviations about the means were large within both aging temperatures. The losses at 35° F are somewhat less than anticipated from commercial practice but the data indicate that weight losses during aging at 110° F for 24 hr are probably not greater than encountered when carcasses are aged for 2 weeks at 35° F.

Samples of muscle were removed during processing for pH determinations. These values showed a more rapid drop in pH when the meat was held at the elevated temperature. However, at 26–28 hr post slaughter the pH of both sides of the carcasses had reached values (5.4 to 5.7) in the normal range for chilled beef.

Tenderization during aging. Broiled steaks from short loins aged at 110° F for 24 hr were much more tender than broiled steaks from unaged (48 hr post slaughter) short loin (Table 2). The aging procedure caused both a marked increase in initial tenderness and a decrease in the amount of residue (the unmasticated material remaining after chewing). The increase in tenderness was somewhat greater than observed by Deatherage and Rieman *(1)* for unprocessed and "Tenderayed" beef of the Commercial and Good grades. The increase in tenderness due to aging in the present experiment was also greater than had been observed previously when individual steaks were

TABLE 2

Mean tenderness and residue scores[1] for short loin steaks from unaged carcasses and carcasses aged 24 hours at 110° F

Treatment	Initial tenderness		Residue	
	Number of judgments	Score	Number of judgments	Score
Unaged	101	4.7	101	5.5
Aged 24 hr, 110° F	101	7.6***	94	7.7***

*** P<0.001.

[1] Score range—1–10 with increasing tenderness; 1–10 with decreasing residue.

aged *(4)*. These differences may be attributed in part to the post-mortem age of the "unaged" controls. In our previous investigation the control steaks were from rounds held 24 to 48 hr longer at cooler temperatures than those used in this study and some tenderization may have accompanied the additional holding period. This may also be applicable to a comparison of the experiments of Deatherage and Rieman with those in the present study.

A comparison between the tenderness measurements of 4 different muscles from carcass sides aged at 35° F and 110° F is shown in Table 3. A statistical analysis

TABLE 3

Mean tenderness, residue scores and shear values of steaks from carcasses aged at 35° F and 110° F

Muscle	Tenderness				Shear test	
	Initial		Residue			
	Number of judgments	Mean	Number of judgments	Mean	Number[1] of shears	Mean
Long. dorsi						
35°–2 wk	118	7.8	118	7.7	77	7.9
110°–24 hr	118	7.5	117	7.5	72	8.5
Semitendinosus						
35°–2 wk	122	7.4	118	7.2	97	9.0
110°–24 hr	122	6.9	120	6.9	81	9.7
Semimembranosus						
35°–2 wk	126	6.2	126	6.1	109	13.0
110°–24 hr	126	6.5	126	6.3	104	10.8
Biceps femoris						
35°–2 wk	109	6.9	109	6.7	118	11.1
110°–24 hr	116	6.5	116	6.4	102	10.8
All Muscles						
35°–2 wk	475	7.1	471	6.9	401	10.5
110°–24 hr	482	6.8	579	6.8	359	10.1

[1] Shear values obtained from 5 carcasses, other values from 4 carcasses.

for each of the 3 measurements of tenderness appears in Table 4. It may be observed in Table 3 that the taste panel scores for both initial tenderness and residue are slightly higher for steaks removed from the *longissimus dorsi, semitendinosus* and *biceps femoris* of sides aged for 2 weeks at 35° F. For the *semimembranosus* muscle the mean tenderness scores are reversed indicating more tenderization occurred in this muscle under accelerated aging conditions. The difference in response of different muscles to the 2 methods of aging is shown further by the significant muscle x method of aging interaction (Table 4). This pattern of tenderness differences was generally true for all of the carcasses studied. These results suggest that the high temperature aging procedure is more

TABLE 4

Analysis of variance for tenderness scores and shear values of carcasses aged at 35° F and 110° F

Source of variation	Tenderness scores				Shear values	
	Initial tenderness		Residue			
	df	ms	df	ms	df	ms
Method of aging	1	12.1*	1	4.3	1	28.6
Muscles	3	76.7**	3	91.3**	3	506.1**
Animals	3	128.3**	3	26.7**	4	270.0**
Muscles × Aging	3	6.6**	3	3.1	3	233.5**
Muscles × Animals	9	21.6**	9	10.9*	12	4.8
Aging × Animals	3	0.3	3	0.9	4	1.6
A × M × A	9	52.9**	9	28.8**	12	108.8**
Error	924	1.6	918	2.1	720	7.8

* Significant at 5% level.
** Significant at 1% level.
df—degrees of freedom.
ms—mean square.

effective on the less tender muscles within the carcass. As indicated in Table 4 the greater mean tenderness score for the 35° F treatment was significantly higher (5% level) than for the 110° F treatment. The differences between residue scores and shear values due to method of aging were not significantly different.

The previous study *(4)* in which *semimembranosus* steaks were aged had shown a slightly greater tenderization effect on the high temperature aging procedure. Considering only the *semimembranosus* steaks used in this study there is excellent agreement between the two procedures employed.

The statistical analyses in Table 4 indicate also the highly significant differences among animals and muscles for each of the scoring procedures. The muscle x animal interaction for taste panel scores shows further that all muscles were not alike in their response to the aging procedures. The *longissimus dorsi* was the most tender and the *semimembranosus* the least tender.

The mean shear value for all muscles (Table 3) was slightly lower (more tender) for steaks from sides aged at 110° F. There is, however, good agreement between the shear values and taste panel scores for tenderness when the 2 methods of aging are compared within and between muscle groupings.

The notations by the taste panel regarding flavor of the broiled steaks indicated a preference for those from sides or ribs aged at 35° F. While comments indicating the presence of old or stale, and slightly bitter flavors were noted for steaks from both treatments, they were applied more frequently to the steaks from sides aged by the accelerated process. The flavors described as unpleasant by some panel members were to other panel members somewhat similar to those noted in beef which has been aged 3 to 4 weeks at 35° F.

SUMMARY

A previous study employing steaks as the experimental unit had indicated that tenderness of beef could be significantly improved by holding the meat at 110° F for 24 hours.

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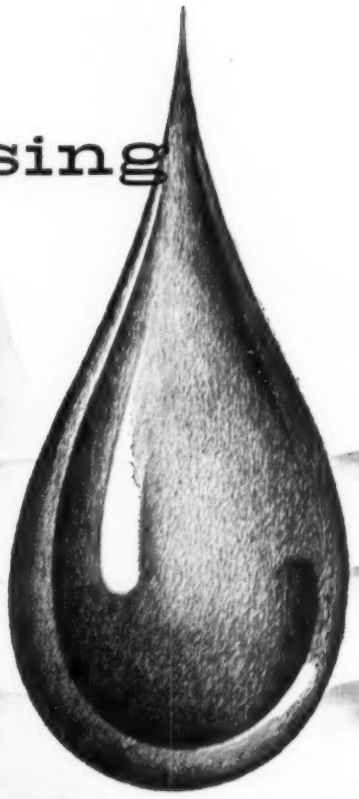

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In this study five beef carcasses were employed to determine the desirability of aging meat in the wholesale cut at elevated temperatures to increase tenderness. Two or three hours prior to slaughter 5 to 10 g of oxytetracycline were given intraperitoneally or intramuscularly in 50 to 100 ml of solution. The injection of the antibiotic in several locations in the tail was found convenient and resulted in tissue levels of 0.5 to 1.0 ppm which was usually sufficient to control bacterial growth during aging.

One hindquarter and rib cut of each carcass was aged for 24 hours at 110° F and the corresponding cuts from the remaining side were aged for two weeks at 35° F. The high temperature aging schedule resulted in a significant increase in tenderness in steaks removed from the short loin *(longissimus dorsi)*. Three muscles of the round and the *longissimus dorsi* of the rib were used to compare the two aging procedures. Taste panel results showed a slightly greater tenderization effect of the 35° F aging procedure. Slight flavor changes were noted in some of the steaks from sides aged at 110° F.

The limited number of carcasses in this study does not permit definite conclusions regarding the commercial application of the accelerated aging procedure. The data show, however, that significant tenderization can be achieved in beef by holding the carcasses at 110° F for 24 hours after slaughter.

Acknowledgments

The authors wish to acknowledge the assistance of the H. Graver Packing Company, Chicago, in providing the facilities for the injection and slaughter of the animals and the cooperation of the Meat Inspection Division of the United States Department of Agriculture. We are also indebted to Dr. J. R. McMahan of Chas Pfizer and Company, Inc., Brooklyn, New York, for his counsel and assistance in the injection of the antibiotic and in performing the antibiotic assays.

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The Effect of Ripening on the Thiamine, Riboflavin, and Niacin Content of Beef from Grain-Finished and Grass-Finished Steers

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(Manuscript received October 19, 1959)

THERE IS LITTLE INFORMATION as to the effects of different feeding regimes on the vitamin content of animal tissue. Cover, Dilsaver, and Hays *(6)* found animal-to-animal variation in the thiamine, pantothenic acid, and riboflavin content of beef and lamb muscles. They found also that the niacin content of lamb tissue varied from one animal to another, pointing out that there is need to determine whether the factors which influence the deposition of the B-vitamins in animal tissue are genetic or environmental. Mayfield and Hedrick *(12)* reported that beef from grain-fed range cattle had about the same thiamine and riboflavin content as beef from cattle fed exclusively on range. Cover and Smith *(7)* found no significant differences in the thiamine content of the ribeye of beef from cattle fed a growing ration of 35% concentrates and of beef from animals fed a fattening ration of 70% concentrates.

Wilcox and Galloway *(19)* reported that 5-month old grass-fat lambs had higher thiamine content than 9-month old lambs fed a grain mixture for about three months. They reported that the differences in riboflavin values for these animals were not significant *(20)*.

In a study of pork, Hartzler, Ross, and Willet *(9)* found no differences in riboflavin and niacin content between grain-fed and garbage-fed hogs, but the thiamine content of pork from the grain-fed hogs was about twice as high as that of garbage-fed hogs. Analysis of the feed showed the grain ration to contain about one and a half times as much thiamine as the garbage ration. Results from several studies of which these are typical *(10, 15)* show that the thiamine content of pork tissue is definitely related to intake.

Limited information is available concerning the effects of post-mortem aging (ripening) on the vitamin content of animal tissues. Dann and Handler *(8)* reported "preliminary experiments with the tissues of rabbits have indicated a definite loss of nicotinic acid after storing the meat for one week in a household refrigerator. The possibility of destruction of nicotinic acid during the commercial ageing of meat of other species requires investigation."

Rice, Fried, and Hess *(16)* found that losses of pantothenic acid, riboflavin, and thiamine were less than 10% in both ground and intact pork muscle when stored at 4° C for less than two weeks. The niacin content of intact pork loin was reduced as much as 54% under these same conditions. In ground flank muscle, niacin remained constant for as long as 56 days when stored at 4° C; thiamine showed a gradual decrease of 11% and riboflavin and pantothenic acid increased to over 150% of the original values, apparently owing to microbial synthesis. In a subsequent study Rice, Squires, and Fried *(17)* again demonstrated that niacin content of intact pork muscle decreased when stored at 4° C. After the first three days, very little, if any, further decrease was noted. No changes in thiamine, riboflavin, and pantothenic acid were observed in pork muscle upon storage for 7 to 14 days under these same conditions, and there was no change in any of these vitamins, including niacin, in ground pork tissue until putrefaction occurred. Limited tests of intact muscles of other species were included in this study. In these tests the niacin content of beef tenderloin and veal loin was found to decrease during storage.

The purpose of the work being reported was to test the effects of ripening on the thiamine, riboflavin, and niacin content of beef muscle tissue from grain-finished and grass-finished steers. It was part of a study of the effects of ripening on the quality of grain-finished and grass-finished beef.

EXPERIMENTAL

Design of experiment. Meat for these tests was taken from 7 pairs of steers. Each pair consisted of a grain-finished and a grass-finished animal of similar genetic background. The grain-finished steers on the average were 20 months old, weighed 1025 lb, and graded USDA High-Good plus. The grass-finished steers averaged 21 months, 925 lb, and graded USDA Low-Good plus. Details of breed, feed management, and the aging procedure have been reported in another paper *(14)*.

Samples from the *longissimus dorsi* muscles in the loin area and from the *semimembranosus* muscles were analyzed for thiamine, niacin, riboflavin, moisture, and fat. Fresh tissues were tested for all but one pair of animals. Samples were prepared for analysis on the day of slaughter, and at 7, 21, and 42 days post-mortem. For the one exception, samples were removed at the appropriate aging time, frozen without grinding, and analyzed about 2 months later.

Sample preparation. Each sample was removed as a cross section of the muscle, trimmed of external fat, and ground 2 times in an electric grinder, first with a coarse blade (1 cm) and then with a fine blade (0.5 cm). The sample was thoroughly mixed after each grinding. A 25 g aliquot of the ground meat was homogenized in pH 4.5 acetate buffer in a Waring blender. Enzymatic extraction and hydrolysis were carried out for the simultaneous release of the B-complex vitamins according to

the procedure described by the Association of Vitamin Chemists *(1)*.

Analyses. Niacin and riboflavin were determined by microbiological assay; thiamine was determined by the thiochrome method. Procedures were essentially those recommended by the Association of Vitamin Chemists *(1)*.[2] Minor modifications were employed in order to adjust conditions to this laboratory. Every determination was carried out in duplicate.

Grain-finished beef tended to have more marbling than grass-finished. Therefore, the percentage of moisture and fat was determined to permit comparison of vitamin values on a fat-free dry basis as well as on a moist basis.

Statistical methods. The data were tested by analysis of variance as outlined by Snedecor *(18)*. The Studentized Range was used to test significance.

RESULTS AND DISCUSSION

Thiamine. Differences in the thiamine content of the grain-finished and grass-finished beef were not significant whether calculated on a moist or a fat-free dry basis (Tables 1 and 4). Aging caused a highly significant change ($P = 0.001$) in the thiamine content of both muscles, the values being significantly higher at 21 days of aging than at any other time tested. However, the magnitude of the increase does not seem large enough to be of nutritional importance. On a moist basis, the thiamine content was significantly higher on the 42nd day of aging than on the day of slaughter. However, this probably did not represent a true increase of thiamine, but rather concentration associated with moisture loss during ripening, as the increase was not significant when calculated on the fat-free dry basis. The *semimembranosus* muscle contained significantly more thiamine ($P = 0.001$) than the *longissimus dorsi* muscle by either basis of calculation.

Riboflavin. Although the average riboflavin values for the grass-finished beef were consistently equal to or higher than those for the grain-finished beef, the differences were not significant (Tables 2 and 4). Aging the beef up to 42 days produced no significant changes in the amount of riboflavin present. The *semimembranosus* muscle contained significantly more of this vitamin ($P = 0.001$) than the *longissimus dorsi* muscle.

Niacin. No significant differences in the niacin content of the beef were associated with the 2 feeding regimes (Tables 3 and 4). Differences in niacin content between the *longissimus dorsi* and *semimembranosus* muscles were not significant.

A highly significant decrease ($P = 0.001$) in the niacin content of beef was associated with aging. On a moist basis the largest post-mortem drop occurred between the time of slaughter and the 7th day, when the average loss of niacin was 27.3%. Further significant losses of 5.6 and 6.9% occurred by the 21st and 42nd day of ripening, respectively. Thus, the niacin content at the end of the 2 longest ripening periods was only about two-thirds of the amount present on the day of slaughter. The decreases were essentially the same when calculated on a fat-free dry basis and, therefore, seem to represent a true disappearance of niacin. In view of the fact that beef can furnish a substantial quantity of niacin to the human diet, this

[2] For one pair of animals the basal medium recommended by Barton-Wright *(2)* was used for the riboflavin assays.

TABLE 1

Thiamine content[1] of beef from grain-finished and grass-finished steers after ripening

Number of days of ripening	Moist basis		Fat-free, dry basis	
	Grain-finished	Grass-finished	Grain-finished	Grass-finished
Longissimus dorsi	*mg/100 g*	*mg/100 g*	*mg/100 g*	*mg/100 g*
0	0.049±0.005	0.051±0.004	0.212±0.022	0.225±0.020
7	0.054±0.005	0.053±0.003	0.238±0.019	0.234±0.017
21	0.058±0.004	0.058±0.004	0.250±0.017	0.255±0.021
42	0.056±0.003	0.056±0.004	0.236±0.016	0.241±0.020
Semimembranosus				
0	0.064±0.006	0.062±0.005	0.274±0.025	0.272±0.021
7	0.065±0.005	0.064±0.005	0.274±0.023	0.270±0.022
21	0.072±0.005	0.072±0.006	0.298±0.022	0.304±0.027
42	0.065±0.005	0.065±0.006	0.267±0.021	0.271±0.024

[1] Average of values from 7 steers.

TABLE 2

Riboflavin content[1] of beef from grain-finished and grass-finished steers after ripening

Number of days of ripening	Moist basis		Fat-free, dry basis	
	Grain-finished	Grass-finished	Grain-finished	Grass-finished
Longissimus dorsi	*mg/100 g*	*mg/100 g*	*mg/100 g*	*mg/100 g*
0	0.17±0.006	0.18±0.005	0.72±0.032	0.78±0.023
7	0.17±0.006	0.19±0.004	0.74±0.030	0.81±0.017
21	0.17±0.008	0.17±0.007	0.71±0.041	0.74±0.032
42	0.17±0.008	0.18±0.012	0.74±0.043	0.77±0.054
Semimembranosus				
0	0.21±0.009	0.22±0.009	0.88±0.038	0.96±0.034
7	0.20±0.007	0.22±0.007	0.82±0.034	0.91±0.029
21	0.19±0.008	0.21±0.008	0.80±0.036	0.87±0.034
42	0.20±0.015	0.21±0.015	0.80±0.070	0.89±0.060

[1] Average of values from 7 steers.

TABLE 3

Niacin content[1] of beef from grain-finished and grass-finished steers after ripening

Number of days of ripening	Moist basis				Fat-free, dry basis			
	Grain-finished	Decrease from day of slaughter	Grass-finished	Decrease from day of slaughter	Grain-finished	Decrease from day of slaughter	Grass-finished	Decrease from day of slaughter
Longissimus dorsi	*mg/100 g*	*%*	*mg/100 g*	*%*	*mg/100 g*	*%*	*mg/100 g*	*%*
0	8.2±0.4	.....	7.7±0.3	.....	35.6±1.9	.....	34.1±1.5	.....
7	6.1±0.2	25.6	5.8±0.2	24.7	27.0±0.9	24.2	25.5±0.8	25.2
21	5.5±0.3	32.9	5.2±0.3	32.5	23.8±1.2	33.1	22.7±1.3	33.4
42	5.3±0.2	35.4	5.2±0.3	32.5	22.4±0.9	37.1	22.2±1.0	34.9
Semimembranosus								
0	8.4±0.4	.....	7.9±0.3	.....	35.0±1.9	.....	34.4±1.5	.....
7	5.8±0.3	31.0	5.7±0.2	27.8	24.3±1.1	32.3	23.9±1.0	30.5
21	5.4±0.2	35.7	5.5±0.2	30.4	22.7±0.7	36.8	22.9±0.6	33.4
42	5.5±0.3	34.5	5.2±0.2	34.2	22.7±1.2	36.8	21.8±0.6	36.6

[1] Average of values from 7 steers.

TABLE 4

Mean squares for thiamine, riboflavin, and niacin

Source	df	Thiamine		Riboflavin		Niacin	
		Moist basis	Fat-free, dry basis	Moist basis	Fat-free, dry basis	Moist basis	Fat-free, dry basis
Replications (Pairs)	6	0.189*	3.92**	0.29	7.65	132.43	3,599.46
Feeds	1	0.000	0.02	0.43	12.17	173.84	2,030.31
Error (Main Plot) (Reps × Feeds)	6	0.023	0.43	0.09	2.08	369.80	4,819.80
Ripening Periods	2	0.033***	0.50***	0.04	1.42	4,671.57***	96,654.64***
Muscles	1	0.390***	5.07***	2.86***	37.47***	7.49	895.18
Ripening Periods × Muscles	3	0.004	0.09	0.03	0.83	27.45	853.47
Ripening Periods × Feeds	3	0.000	0.01	0.01	0.18	16.07	145.71
Feeds × Muscles	1	0.001	0.01	0.04	0.94	1.25	132.55
Feeds × Ripening Periods × Muscles	3	0.000	0.01	0.00	0.08	11.06	158.72
Error (Subplot)	84	0.003	0.05	0.04	0.59	27.93	531.67

* Significant at P = 0.05.
** Significant at P = 0.01.
*** Significant at P = 0.001.

decrease may have some nutritional significance. Other workers *(8, 16, 17)* have also found decreases in the niacin content of beef and other species during storage.

Quite a variation of values for the niacin content of beef have been reported in the literature *(3, 4, 5, 8, 11, 13)*. It seems possible that the post-mortem age of the tissue at the time of analysis may be a factor responsible for this lack of agreement.

SUMMARY

The amount of thiamine, riboflavin, and niacin in the *longissimus dorsi* and *semimembranosus* muscles of grain-finished and grass-finished beef from genetically similar steers was determined on the day of slaughter, and at 7, 21, and 42 days of ripening. Values are reported on a moist and on a fat-free dry basis.

No significant differences in the raw tissue content of these 3 vitamins were associated with the 2 feeding regimes. Both grain-finished and grass-finished beef would seem to be equally satisfactory sources of thiamine, riboflavin and niacin.

There was a slight, but highly significant increase ($P = 0.001$) in thiamine content at 21 days of aging. Aging up to 42 days had no significant effect on the amount of riboflavin present. The niacin content of the beef decreased about 25 to 30% between the day of slaughter and the 7th day of aging. This decrease was highly significant ($P = 0.001$). Further significant losses of 5.6 and 6.9% of niacin were found by the 21st and 42nd day of ripening respectively.

The *semimembranosus* muscle was found to contain significantly more ($P = 0.001$) thiamine and riboflavin than the *longissimus dorsi* muscle. However, the niacin content of these two muscles was not significantly different.

Acknowledgment

The authors wish to thank Dr. L. E. Orme of the Animal Husbandry Department for the statistical analysis of the data.

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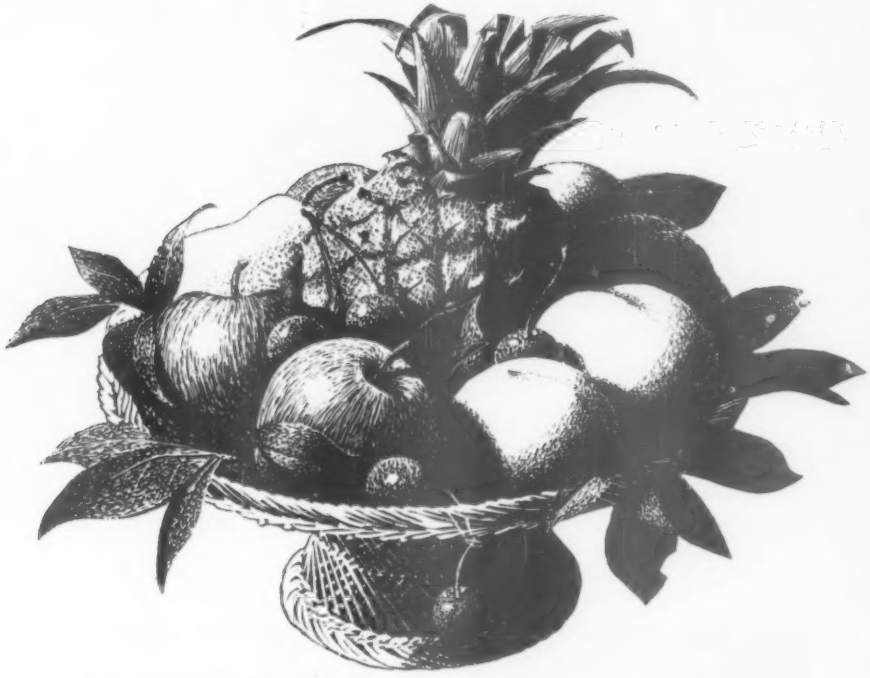

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TECHNICAL PROGRAM AND ABSTRACTS

AND

GENERAL AND SOCIAL EVENTS

Twentieth Annual Meeting

of the

Institute of Food Technologists

May 15 through May 19, 1960

San Francisco, California

and

Pacific Rim Food Conference

May 20 through May 25, 1960

Honolulu, Hawaii

GENERAL AND SOCIAL EVENTS

FRIDAY, MAY 13, 1960

Executive Committee Meeting
9:00 A.M.—Crystal Room (Mezzanine) Fairmont Hotel

SATURDAY, MAY 14, 1960

Registration
10:00 A.M.-5:00 P.M.—Foyer, Masonic Temple

Northern California Section Committee Meeting
7:00 P.M.—Florentine Room, Fairmont Hotel

Editorial Board Meeting
7:30 P.M.—California Room, (Mezzanine), Fairmont Hotel

SUNDAY, MAY 15, 1960

Registration and Tickets
9:00 A.M.-5:00 P.M.—Foyer, Masonic Temple
6:00 P.M.-8:30 P.M.—Lobby, Fairmont Hotel

National Council Meeting
10:00 A.M.—Nob Hill Room, Lobby Floor, Fairmont Hotel

Exhibits—Official Opening
1:00 P.M.-5:00 P.M.—Exhibit Hall, Masonic Temple

Ladies' Welcome Tea
2:30 P.M.-4:30 P.M.—California Room, Fairmont Hotel

Social Hour (all registrants)
6:30 P.M.—Gold Ball Room, Fairmont Hotel

MONDAY, MAY 16, 1960

Section Officers' Breakfast
7:30 A.M.—Golden Empire Room, Mark Hopkins Hotel

University of Illinois Breakfast
7:30 A.M.—Conquistador Room, Mark Hopkins Hotel

University of Massachusetts Breakfast
7:30 A.M.—Argonaut Room, Mark Hopkins Hotel

General Session
8:45 A.M.—Auditorium. Masonic Temple

Ladies' Tour, Luncheon, Bay Cruise
9:00 A.M.—Buses leave from front of Fairmont

Registration and Tickets
9:00 A.M.-5:00 P.M.—Foyer, Masonic Temple

Technical Sessions
10:20 A.M.—Masonic Temple
1:40 P.M.—Masonic Temple

Exhibits
11:00 A.M.-4:30 P.M.—Exhibit Hall, Masonic Temple

Mexican Luncheon (all registrants welcome)
12:15 P.M.—Papagayo Room, Fairmont Hotel

University of California Dinner
7:30 P.M.—Tonga Room, Fairmont Hotel

Convenience Food Packaging Problems—Seminar
8:00 P.M—Far East Room, Fairmont Hotel

Flavor Nomenclature Committee
8:00 P.M.—20th Century Room, Fairmont Hotel

Citrus Products Committee
8:00 P.M.—Frontier Room, Fairmont Hotel

TUESDAY, MAY 17, 1960

Oregon State College Breakfast
7:30 A.M.—Argonaut Room, Mark Hopkins Hotel

Massachusetts Institute of Technology Breakfast
7:30 A.M.—Golden Empire Room, Mark Hopkins Hotel

University of Wisconsin Breakfast
7:30 A.M.—Baldwin Room, Mark Hopkins Hotel

University of Georgia Breakfast
7:30 A.M.—Conquistador Room, Mark Hopkins Hotel

Pennsylvania State University Alumni Breakfast
7:30 A.M.—Phoenix Room, Mark Hopkins Hotel

Technical Sessions: 8:40 A.M.—Masonic Temple

Registration and Tickets
9:00 A.M.-5:00 P.M.—Foyer, Masonic Temple

Ladies Continental Breakfast, Shop Tour
9:15 A.M—Starlight Roof, Sir Francis Drake Hotel

Exhibits
11:00 A.M.-4:30 P.M.—Exhibit Hall, Masonic Temple

University of Minnesota Luncheon
12:15 P.M.—Conquistador Room, Mark Hopkins Hotel

Babcock-Hart Award Address
1:30 P.M.—Auditorium, Masonic Temple

Technical Sessions: 2:20 P.M.—Masonic Temple

Awards Banquet
7:00 P.M.—Gold Ballroom, Fairmont Hotel

WEDNESDAY, MAY 18, 1960

Phi Tau Sigma Breakfast
7:30 A.M.—Argonaut Room, Mark Hopkins Hotel

Canadian Breakfast
7:30 A.M.—Golden Empire Room, Mark Hopkins Hotel

Purdue University Alumni Breakfast
7:30 A.M.—Baldwin Room, Mark Hopkins Hotel

Technical Sessions: 8:40 A.M.—Masonic Temple

Registration and Tickets
9:00 A.M.-5:00 P.M.—Foyer, Masonic Temple

Ladies' Tour to Redwoods, Luncheon, Shops
9:00 A.M.—Buses leave from the Fairmont Hotel

Exhibits (Final day)
11:00 A.M.-4:00 P.M.—Exhibit Hall, Masonic Temple

Appert Award Address
1:30 P.M.—Auditorium, Masonic Temple

Business Meeting and Exhibitors Prize Drawing
2:10 P.M.—Auditorium, Masonic Temple

Technical Sessions
2:40 P.M.—Masonic Temple

THURSDAY, MAY 19, 1960

Field Trips. All buses leave from front of Fairmont Hotel

8:30 A.M.-4:30 P.M.—Napa Valley Wineries Tour

8:30 A.M.-4:30 P.M.—University of California, Davis

8:30 A.M.-4:30 P.M.—Tri-Valley Packing, Sunsweet Growers, Mission San Jose

8:30 A.M.-4:30 P.M.—United Air Lines Commissary, Heublein, Inc., Stanford Research Institute (Complimentary lunch).

8:30 A.M.-4:30 P.M.—Ac'cent-International and Morton Salt. (Complimentary lunch).

9:00 A.M.-3:00 P.M.—Filice and Perrelli Canning, U.S.D.A. Western Regional Research Laboratory. (Complimentary lunch)

TWENTIETH ANNUAL MEETING

General Information

REGISTRATION FEES

Members	$10.00
Non-members	15.00
Student Members	2.00
Student Non-members	3.00
Exhibitors—6 for each exhibit	Free
Exhibitors—each additional	5.00
Wives or Husbands of members	Free

HEADQUARTERS ROOMS

IFT Headquarters . . Room 105, Masonic Temple
Press Room . . . . Room 103A, Masonic Temple
Employment . Rooms 101, 102, 103 Masonic Temple
Ladies' Hospitality Room . Empire Room—Fairmont
Registration and Information . Foyer, Masonic Temple

TICKETS

Tickets are required for all social events, ladies' trips, plant trips, banquet, special meals, etc. Ticket sales are limited to registered personnel presenting badges and ticket order forms, at least 12 hours prior to the event in order to guarantee accommodation. There will be no refund on tickets less than 12 hours prior to an event.

MEALS

Cold buffet lunches with hot coffee will be available from kitchen adjacent to Exhibit Hall, Masonic Temple, at popular prices. Both the Fairmont and the Mark Hopkins Hotels have lunch and dining rooms serving more elaborate meals.

The Mexico Section invites all registrants to a luncheon on Monday, May 16, prepared and served in true Mexican style. The Papagayo Room in the Fairmont Hotel is an appropriate setting for this interesting event. Limited to 200.

EXHIBITS

All exhibits are located in the Exhibit Hall, Masonic Temple.

Admission to the Exhibit area is limited to registered personnel presenting badges.

The visiting hours are:

Sunday, May 15	1:00 P.M. to 5:00 P.M.
Monday, May 16	11:00 A.M. to 4:30 P.M.
Tuesday, May 17	11:00 A.M. to 4:30 P.M.
Wednesday, May 18	11:00 A.M. to 4:00 P.M.

All the newest developments in laboratory facilities, flavors, other ingredients, processing equipment and many other tools of the profession will be on display. Be sure to allow adequate time to carefully inspect these exhibits.

EMPLOYMENT

Complete listing of food technology openings and available food technologists' qualifications may be consulted by qualified registrants at the Employment Committee offices, Rooms 101, 102 and 103 (behind the Auditorium) Masonic Temple. Office hours are as follows:

Sunday	1:30 P.M.—4:30 P.M.
Monday	8:00 A.M.—12:00 M.
	1:00 P.M.—4:30 P.M.
Tuesday—	same
Wednesday—	same

To facilitate the smooth operation of this service, applications should be received prior to the meeting. Every effort will be made to maintain complete anonymity of all listings until it is determined that no embarrassment will result from revealing names.

LADIES ENTERTAINMENT

A program which will include some of the highlights of San Francisco and California scenery, shopping and food awaits the Ladies attending the Annual Meeting. Atop Nob Hill, where the Fairmont Hotel and the Masonic Temple are located, we have a beautiful and central starting point for just about anything you may want to do. We will have a Ladies Hospitality Room in the Fairmont on Monday, Tuesday and Wednesday from 8:30 A.M. to 5:30 P.M. where our hostesses will be on hand to answer your questions about museums, shopping, restaurants, etc.

But as you go through the program we have planned we hope you will come along with us and let us be your guide.

Sunday will be the first get-together with a Welcoming Tea in the California Room at the Fairmont. Please drop in to meet old and new friends between 2:30 and 4:30 in the afternoon.

Monday morning at 9:00 we will board buses at the Main Entrance of the Fairmont for a tour of the City, ending at No. 9 Fisherman's Grotto for a wine luncheon. Then a one-hour Bay Cruise before hopping the cable car for a return to Nob Hill about 3:30 P.M.

Tuesday morning at 9:15 we will meet at the Starlight Roof of the Sir Francis Drake Hotel, on Powell Street, just down the Hill from the Fairmont, for a Continental Breakfast. Here we will gather into small groups and be off on a walking tour of some of our fascinating shops and stores. We will end the tour in Chinatown where you can browse at your leisure, have lunch or return to the Fairmont (cable cars, of course). The afternoon will be free to do as you desire.

Wednesday at 9:30 A.M. we will again board the buses at the Fairmont and travel across the Golden Gate Bridge to Muir Woods, where you can meander in the serene atmosphere of the Giant Redwoods. Then to lunch on the terrace at the Alta Mira, overlooking Bohemian Sausalito. We will take you to the Trade Fair where you can see (and maybe buy) some of California's fine wares. Back to the Fairmont about 4:00 P.M.

This completes the Ladies Program, but, of course, there is entertainment planned for the group—the reception Sunday evening, and Awards Banquet Tuesday evening. You are also included in the Field Trips on Thursday, which look quite exciting.

Since we want to plan the best service for you, purchase your tickets well in advance and take advantage of the "package deal" we offer you. And we're sorry, but we cannot make refunds once the tickets have been purchased.

FIELD TRIPS

On each of the plant tours there is a maximum number of tickets available. They will be distributed on a first come-first served basis to all registered applicants and their wives.

In the event the quota for the field trip you select is filled, the fare will be refunded at the registration desk. Maximum registration is indicated in the description of the tours.

A more complete description of each field trip will be available at the registration desk.

Buses for all field trips will leave from the front of the Fairmont Hotel.

NAPA VALLEY WINERIES TOUR

A visit to two of the famous bottling wineries of the beautiful Napa Valley, and an opportunity to evaluate wines which have made this area world famous are offered on the tour. This trip will be through some of California's most scenic country, via the San Francisco-Oakland Bay Bridge and returning by the Golden Gate Bridge.

The tour departs at 8:30 A.M. and returns at 4:30 P.M. It is limited to 320 people.

UNIVERSITY OF CALIFORNIA AT DAVIS

This trip will give an opportunity to view the University of California's elaborate dairy, food processing and wine research facilities. There will be a luncheon stop at the famous Nut Tree Restaurant and Gift Shop near Vacaville. The tour departs at 8:30 A.M. and returns at 4:30 P.M. It is limited to 80 people.

MISSION SAN JOSE, SUNSWEET, AND TRI-VALLEY PACKING ASSOCIATION

This tour will include a visit to historic Mission San Jose, which was built in 1797 by the Catholic Padres as a part of the chain of missions built throughout California before the Gold Rush. The Sunsweet plant is unique to California. The plant is the largest, most modern, dried fruit plant in the world. The Tri-Valley Packing Association, which is a typical California cannery, will be processing asparagus, an important California canning crop. The tour route will take you through the apricot, prune, and pear orchards of the Santa Clara Valley. The tour departs at 8:30 A.M. and returns at 4:30 P.M., and is limited to 80 people.

UNITED AIR LINES COMMISSARY, HEUBLEIN AND STANFORD RESEARCH INSTITUTE

The United Air Lines Commissary handles the preparation of meals for the many flights originating from San Francisco. At Heublein, Inc., you will be able to watch the manufacture of vodka and the aseptic processing of their famed canned soups. Stanford Research Institute is one of the best known private research organizations in the United States. The Institute is engaged in many research projects related to foods. This trip departs at 8:30 A.M. and returns at 4:30 P.M. It is limited to 80 people. A complimentary luncheon will be served, courtesy of Heublein, Inc.

WESTERN REGIONAL RESEARCH LABORATORY AND FILICE & PERRELLI CANNERY

The Western Regional is one of the four branch laboratories of the Agricultural Research Service. Utilization research on Western fruits, nuts, vegetables, dry beans, poultry products and certain field crops and fibers is being conducted. Filice and Perrelli is a typical California fruit cannery, spic and span and ready for the coming fruit processing season. The tour route, via the three famous Bay Area bridges, gives a bird's eye view of the Bay Area. The trip departs at 9:00 A.M. and returns at 3:00 P.M. A complimentary lunch will be served, courtesy of Filice and Perrelli. The tour is limited to 40 people.

AC'CENT AND MORTON SALT

Depart 8:30 A.M. and return 4:30 P.M., trip limited to 40 people, transportation and lunch compliments of Ac'cent and Morton Salt.

The Newark, California, plant of the Morton Salt Company specializes in the production of high-purity evaporated salt for home and industry. Prior to its introduction to the vacuum evaporators, the salt brine is chemically treated to remove all objectionable impurities. High-purity salt produced from the treated brine is then dried and cooled in stainless steel rotary kilns. The salt is then carefully screened, mixed with any required additives, and bagged for shipment by rail or truck. The tour will cover each of these salt production phases in their proper sequence.

Special tour through the sunny, rich Santa Clara Valley as guests of International Minerals & Chemical Corporation. Here is the home of AC'CENT. Guests will see how monosodium glutamate is made for use by homes, restaurants and food processors throughout the world and enjoy a Western ranch-style meal at the La Rinconada, compliments of Ac'cent.

THE TECHNICAL PROGRAM

IN SUMMARY

Monday Morning—May 16

8:45—10:15
General Session, Auditorium, Masonic Temple

10:20 Concurrent Sessions
Section A—Food Additives—Auditorium
Section B—Fruit Products—Room 3-4
Section C—Fish, Meat, Poultry—Room 5-6
Section D—Microbiology and Public Health—Room 7-8

Monday Afternoon

1:40 Concurrent Sessions
Section A—Convenience and Instant Foods—Auditorium
Section B—General Research—Room 3-4
Section C—Basic Research—Food Enzymes—Room 5-6
Section D—Fish, Meat, Milk and Poultry—Room 7-8

Monday Evening

FAIRMONT HOTEL

8:00 Concurrent Sessions
Section A—Convenience Foods Packaging Problems—Far East Room
Section B—Flavor Nomenclature Committee—Twentieth Century Room
Section C—Citrus Products Committee—Frontier Room

Tuesday Morning—May 17

8:40 Concurrent Sessions
Section A—Food Engineering—Masonic Temple Auditorium
Section B—Fruit Products—Room 3-4
Section C—Basic Research—Food Lipids—Room 5-6
Section D—Fish, Meat and Poultry—Room 7-8

Tuesday Afternoon

1:30 General Session
Babcock-Hart Award Address—Masonic Temple Auditorium

2:20 Concurrent Sessions
Section A—Food Engineering—Auditorium
Section B—Citrus Products—Room 3-4

2:40 Concurrent Sessions
Section C—Basic Research—Food Proteins—Room 7-8
Section D—Fish, Meat and Poultry—Room 5-6

Wednesday Morning—May 18

8:40 Concurrent Sessions
Section A—Quality control—Instrumentation, Statistical Quality Control—Masonic Temple Auditorium
Section B—Vegetable Products—Room 3-4
Section C—Fish, Meat and Poultry—Room 5-6
Section D—Radiation Preservation—Contributed Papers, Symposium Papers—Room 7-8

Wednesday Afternoon

General Session—Masonic Temple Auditorium
1:30 Nicholas Appert Award Address

2:10 Business Meeting

2:40 Concurrent Sessions
Section A—Quality Control, Vegetable Products Auditorium
Section B—Basic Research—Flavor Chemistry—Room 3-4
Section C—Fish, Meat and Poultry—Room 5-6
Section D—Microbiology and Public Health—Room 7-8

THE PROGRAM IN DETAIL

MONDAY MORNING—MAY 16

General Session

Auditorium—Masonic Temple

Chairman: GEORGE F. STEWART
University of California, Davis

8:45— Official Opening
J. H. KILBUCK, William J. Stange Co.

9:00— Presidential Address
R. B. WAKEFIELD, Gerber Products Co.

9:30— Scholarship and Fellowship Awards
A. C. RICHARDSON, California Packing Corp.

10:00— Food Technology Achievement Award
B. S. CLARK, Maine Sardine Council

Concurrent Sessions

Section A—Auditorium

Food Additives

Chairman: J. F. MAHONEY
Merck & Company

10:20— 1. Recent Progress in the Consideration of Flavoring Ingredients under the Food Additives Amendment
RICHARD L. HALL, McCormick & Co.

10:30— 2. Food Colors—Their Status under the Law
ARTHUR T. SCHRAMM, Allied Chemical Corp.

10:50— 3. An Organic Chemist's Approach to Some Problems Raised by the Food Law Amendment
L. E. SCHNIEPP, H. O. ETIAN and J. M. JACKSON, American Can Co.

11:10— 4. Biological Screening Techniques for Food Additives
MARGARET IVES and EDYTHE M. NAGLER, American Can Co.

11:30— 5. A System for Application of the Food and Drug Act (as Amended) in a Multi-Plant, Multi-Product Food Company
ZENAS BLOCK, PAUL KHAN, and PAULINE GOLDMAN, DCA Food Industries

11:45— 6. Antibiotic Preservation of Beef with Subsequent Feeding to Experimental Animals
R. B. SLEETH, J. C. ARMSTRONG, H. S. GOLDBERG, H. D. NAUMANN, Univ. of Missouri and Armour & Co.

MONDAY MORNING—MAY 16

Section B—Room 3-4

Fruit Products

Chairman: WALTER MERCER
National Canners Association

10:20— 7. Characteristics of Browning Enzymes in Fay Elberta Freestone Peaches
PHILIP REYES and B. S. LUH, Univ. of Calif., Davis

10:35— 8. Estimation of the Chlorophyll Content and Maturity of Elberta Peaches by Use of Light-Transmittance Techniques
ARTHUR P. SIDWELL, GERALD S. BIRTH, JANE V. ERNEST, and CALVIN GOLUMBIC, Agr. Mktg. Services, U.S.D.A.

10:50— 9. Browning of Sugar Solutions. VI. Isolation and Characterization of the Brown Pigments in Maple Sirup
HARRY G. LENTO, C. O. WILLITS and J. C. UNDERWOOD, Eastern Regional Research Lab., U.S.D.A.

11:10— 10. The Correlation of Color Measurements on Canned Purple Plums with Consumer Acceptability
OLIVER J. WORTHINGTON, Oregon State College

11:30— 11. Compounds Responsible for the Color of Black "Ripe" Olives
KENNETH L. SIMPSON, C. O. CHICHESTER and R. H. VAUGHN, Univ. of Calif., Davis

11:50— 12. Diffusion Studies on Oligosaccharides
M. C. BOURNE, C. O. CHICHESTER and C. STERLING, Univ. of Calif., Davis

12:10— 13. Some Aspects of the Use of Sugars in Food Processing
H. B. HASS, Sugar Research Foundation

MONDAY MORNING—MAY 16

Section C—Room 5-6

Fish, Meat and Poultry

Chairman: C. O. BALL
Rutgers University

10:20— 14. Spectrophotometric Studies of the Pigments of Cooked and Cooked-Cured Meats
A. L. TAPPEL, Univ. of Calif., Davis

10:40— 15. Tryptophan and Hydroxyproline as the Indexes of Muscle Plasma Proteins and the Connective Tissue in Animal Tissues and Their Use for the Estimation of Nutritional Values of Meat and Meat Products
EUGEN WIERBICKI, GEORGE CHRISTIANSON and ROBERT C. BURRELL, Rath Packing Co.

11:00— 16. Comparison of Rate of Cooking and Doneness of Fresh and Frozen Defrosted Turkey Hens
GRAYCE E. GOERTZ, ANNA S. HOOPER and DOROTHY L. HARRISON, Kansas State University

11:20— 17. The Effect of Oven Air Temperature, Air Flow and Pressure on the Roasting of Rounds of Beef (Yield and Roasting Time)
CHARLES M. SCHOMAN, JR. and C. OLIN BALL, U. S. Naval Supply Research & Development Facility and Rutgers University

11:40— 18. Moisture Content of Pork Meat and Its Relationship to Leanness
E. KARMAS, H. E. WISTREICH and J. E. THOMPSON, Reliable Packing Co.

MONDAY MORNING—MAY 16

Section D—Room 7-8

Microbiology and Public Health

Chairman: R. H. VAUGHN
University of California, Davis

10:20— **19.** A Comparison of the Inhibitory Effects of Sorbate, Benzoate and Vitamin K_5 on Selected Yeast Strains
E. S. SMITH, J. F. BOWEN and D. R. MacGREGOR, Canadian Dept. of Agr. (Canada)

10:40— **20.** Benzoate-Resistant Yeasts
M. INGRAM, Low Temperature Research Station (England)

11:00— **21.** Germicidal Effect of Orange Peel Oil and D-Limonene in Water and Orange Juice. Part I. Fungicidal Properties Against Yeast
D. I. MURDOCK and W. E. ALLEN, Minute Maid Corporation

11:20— **22.** The Sanitation Aspects of Food Plant Construction and Equipment Design and Installation
BENJAMIN BUCHALTER, Industrial Sanitation Service

11:40— **23.** Microbiological Standards for Foods
M. INGRAM, Low Temperature Research Station (England)

12:00— **24.** Pest Control—Ex Post Facto?
BENJAMIN BUCHALTER, Industrial Sanitation Service

MONDAY AFTERNOON—MAY 16

Concurrent Sessions

Section A—Auditorium

Convenience and Instant Foods

Chairman: E. B. OBERG
Carnation Company

1:40— **25.** Commercial Development of an Aerosol Whipped Topping
HEBER R. BALDWIN, National Dairy Research Labs

2:10— **26.** The Role of Convenience in Food Selection
M. E. JOHN, R. L. BAKER, H. B. BYLUND, T. M. BROOKS, Penn. State Univ.

2:30— **27.** Direct Processes for Production of Potato Granules
C. E. HENDEL, G. K. NOTTER, R. M. REEVE, M. E. LAZAR and W. R. MULLINS, Western Regional Research Lab., U.S.D.A.

2:50— **28.** The Vitamin Fortification of Potato Flakes
JAMES CORDING, JR., RODERICK K. ESKEW, G. J. SALINARD and JOHN F. SULLIVAN, Eastern Regional Research Lab., U.S.D.A. and Hoffman-La Roche, Inc.

3:10— **29.** Development of Pre-Cooked, Dehydrated Meat Items for Military Use
J. M. TUOMY, ROSARIO BUSCEMI, and M. C. BROCKMANN, Quartermaster Food & Container Institute for the Armed Forces

3:30— **30.** Some Practical Factors to Consider in Using Instant Nonfat Dry Milk in Quantity Food Preparation
MADGE LITTLE, American Dry Milk Institute

3:50— **31.** Instant Bread Mix: Consumer Acceptance of Prepared Bread
MARION SIMONE, NANCY SHARRAH and C. O. CHICHESTER, Univ. of Calif., Davis

4:10— **32.** The Effect of Preparation on the Stability and Performance of Frozen, Unbaked Yeast-Leaven Doughs
PAUL P. MERRITT, Red Star Yeast & Products Co.

4:30— **33.** Instant Bread Mix: Studies on the Dehydration of Flavoring Materials
C. O. CHICHESTER, NANCY SHARRAH and MARION SIMONE, Univ. of Calif., Davis

4:50— **34.** Granulated Potato Flakes
RODERICK K. ESKEW, JOHN F. SULLIVAN, FRED H. DRAZGA and CHARLES F. WOODWARD, Eastern Regional Research Lab., U.S.D.A.

MONDAY AFTERNOON—MAY 16

Section B—Room 3-4

General Research

Chairman: J. H. GAST
Resources Research, Inc.

1:40— **35.** Precipitation of Food Gums by Thiazine, Oxazine Azine and Other Basic Dyes: Specificity of the Methylene Blue—Carrageenan Reaction
HORACE D. GRAHAM and LINNIE B. THOMAS, Carver Foundation, Tuskegee Institute

2:00— **36.** Spectrophotometric and Chromatographic Studies of *Hibiscus* Sabdariffa Extracts
HUSSEIN O. A. OSMAN, Univ. of Alexandria (UAR) and Rutgers Univ.

2:20— **37.** Estimation of Alcohol and Sugar Contents of Alcoholic Beverages by Refractive Index, Specific Gravity, and Dilatometric Methods
R. J. VILECE and A. S. LEVINE, Univ. of Florida

2:40— **38.** Rapid Method for Removing Organic Coatings from Tin Cans
CHARLES H. COLEMAN and JOHN E. DESPAUL, Quartermaster Mil. Subs. Testing Lab., Chicago

3:00— **39.** The Effect of Method of Care on the Frying Life of Fat
M. ELIZABETH RUST and DOROTHY L. HARRISON, Kansas State Univ.

3:20— **40.** Some Factors Affecting the Inhibition of the Cupric Oxidation of Ascorbic Acid by Calcium EDTA (Disodium Calcium Ethylenediamine Tetraacetate)
PAUL A. WOLF, Dow Chemical Co.

3:40— **41.** Oxygen-Scavengering Packet for In-Package Deoxygenation
DON SCOTT and FRANK E. HAMMER, Fermco Laboratories

4:00— **42.** Long-Term Storage of Processed Foods
S. R. CECIL and J. G. WOODROOF, Georgia Agr. Exp. Station

4:20— **43.** Natural Gums and Stabilizers for the Food Processor
LEONARD M. WALDT, Morningstar-Paisley, Inc.

4:40— **44.** Studies on English (Persian) Walnuts, *Juglans Regia.* II. Stabilization of Kernels
LOUIS B. ROCKLAND, Fruit & Veg. Chem Lab., U.S.D.A. and D. M. SWARTHOUT and R. A. JOHNSON, Diamond Walnut Growers Inc., Stockton

MONDAY AFTERNOON—MAY 16

Section C—Room 5-6

Basic Research—Food Enzymes

Chairman: L. A. UNDERKOFLER
Miles Chemical Company

1:40— Introductory remarks
EDWARD S. BECKHORN, Wallerstein Co.

1:50— **45.** Comparative Action of Proteases on Proteins
R. M. HEINICKE, R. MORI and S. NAKATA, Hawaiian Pineapple Co.

2:10— **46.** Properties of the Acid Phosphatases in Commercial Pineapple Stem Bromelain
R. M. HEINICKE, A. CHUN and R. MORI, Hawaiian Pineapple Co.

2:30— **47.** The Inhibition of Polygalacturonase in Brined Cherries
H. Y. YANG, WILBERT F. STEELE and DONALD J. GRAHAM, Oregon State College

2:50— **48.** Developments in the Role of Enzymes in the Softening of Brined Cherries
MYRON J. POWERS, EDWARD ROSS, GLENN G. WATTERS, ROGERNALD JACKSON and JOHN E. BREKKE, Washington State Univ., and Western Regional Research Lab., U.S.D.A.

3:10— **49.** Enzymatic Conversion of Barley Carbohydrates to Syrup
K. J. GOERING and M. J. HOULE, Montana State College

3:30— **50.** The Complementary Effects of Thermal Energy and Ionizing Energy on Peroxidase Activity in Green Beans
R. W. BAKER and S. A. GOLDBLITH, Massachusetts Institute of Technology

3:50— **51.** The Action of an Enzyme for the Flavor Enhancement of Legumes
RICHARD R. BARTON, Miles Chemical Co.

4:10— **52.** Studies of the Enzymes and Metabolites Occurring in Fish
M. R. GUMBMANN, W. D. BROWN, and A. L. TAPPEL, Univ. of Calif., Davis

4:30— **53.** Action of Bacterial Lipases on Natural Fats as Determined by Gas Chromatography
JOHN A. ALFORD, LLEWELLYN E. ELLIOTT and LEROY C. BLANKENSHIP, Eastern Regional Research Lab., U.S.D.A.

MONDAY AFTERNOON—MAY 16

Section D—Room 7-8

Fish, Meat, Milk and Poultry

Chairman: ALOYS TAPPEL
University of California, Davis

1:40— **54.** The Chemical Composition of Beef Protein Fractions Before and After Irradiation
P. A. HEDIN, G. W. KURTZ and ROBERT B. KOCH, Quartermaster Food & Container Institute for the Armed Forces

2:00— **55.** A Study of Physical and Chemical Changes in Beef Protein Caused by Lyophilization
DOROTHY A. JOHNSON, GEORGE W. KURTZ and ROBERT B. KOCH, Quartermaster Food & Container Institute for the Armed Forces

2:20— **56.** The Proximate Composition of Pacific Ocean Perch and Nine Other Species of Rockfish
CLAUDE E. THURSTON, Bureau of Commercial Fisheries, U.S.D.I.

2:40— **57.** The Chemical Composition of Raw, Precooked, and Canned Tuna. I. Core Sampling Methods
CLARENCE J. CARLSON and CLAUDE E. THURSTON, Bureau of Commercial Fisheries, U.S.D.I.

3:00— **58.** Effect of Vinyl Film Packaging on Palatability of Frozen Turkey Fryer-Roasters
J. D. WINTER, SHIRLEY R. TRANTANELLA, MILO H. SWANSON and W. B. ACKART, Univ. of Minnesota

3:20— **59.** The Effectiveness of Selected Films for Fresh Beef Color Stability in Self-Service Retail Display
G. H. WELLINGTON, Cornell University

3:40— **60.** Determination, in Egg White, of Lipids and Their Effects Upon Performance
CHARLES F. SMITH, CHARLES K. STEARNS and EUGENE KOLEN, National Dairy Products Corp.

4:00— **61.** Effects of Different Thawing Temperatures on Frozen Concentrated Milk
ALEXANDER SPEAR, U. S. Naval Supply Research and Development Facility

MONDAY EVENING—MAY 16

FAIRMONT HOTEL

Section A—Far East Room

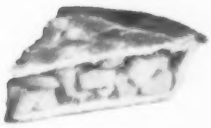
8:00— Convenience Foods Packaging Problems
Discussion Leader—C. P. BOLTON, Carnation Co.

Section B—Twentieth Century Room

8:00— Flavor Nomenclature Committee
Chairman—R. A. BERNHARD, Univ. of Calif., Davis

Section C—Frontier Room

8:00— Citrus Products Committee
Chairman—C. H. BROKAW, Minute Maid Corp.



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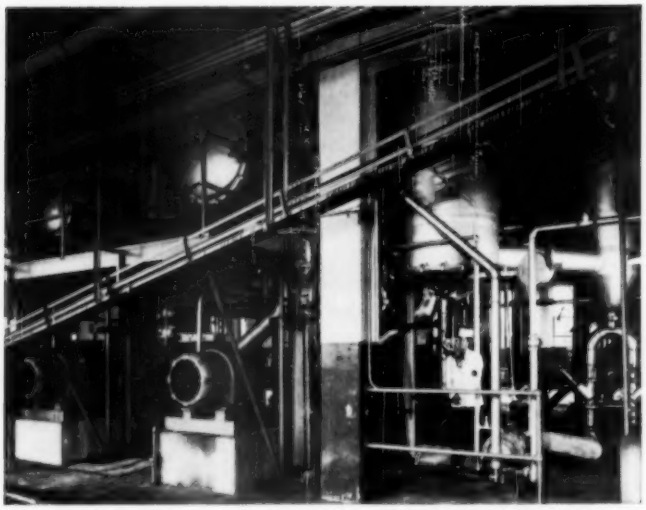
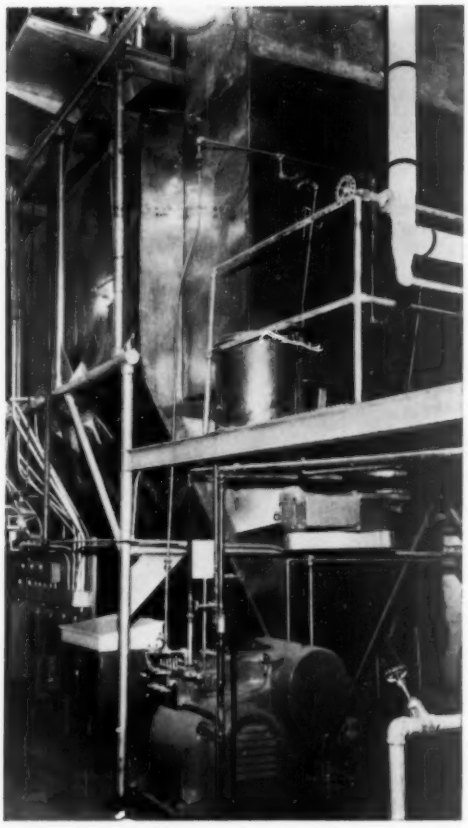
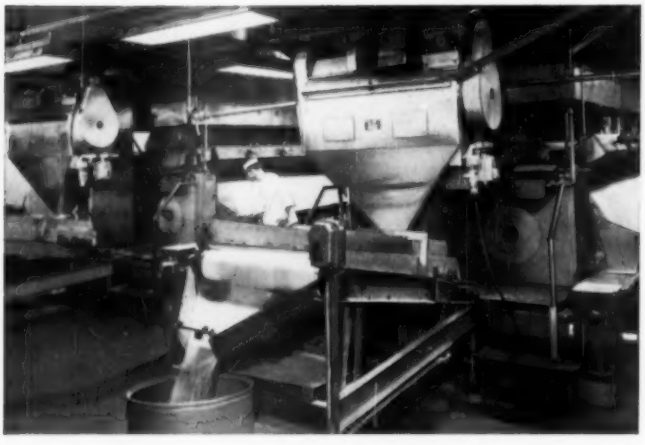


Triple-effect evaporator has increased tomato paste production over 100% at American Home Food's Oakland, California plant.



Spray Dryer as used by Mid-West Solvents at Atchison, Kansas to produce a superior grade of vital gluten used for food enrichment.



Drum Dryers produce 210,000 pounds of flaked cereal for Beech Nut's Rochester, N. Y. plant. They work a 140-hour week, take just 4 hours to clean.

Buflovak engineers equipment to cut food processing costs

Pictured here is equipment that upgrades food products, speeds food processing. These installations are the result of close teamwork between processor and Buflovak engineers.

Backed by a complete line of dryers, evaporators, flakers, autoclaves, and kettles, Buflovak impartially recommends the right equipment to meet your needs. Whenever product research indicates the need for custom units, Buflovak has the design know-how and production facilities to follow through.

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Buflovak Equipment Division

BLAW-KNOX

TUESDAY MORNING—MAY 17

Concurrent Sessions

Section A—Masonic Temple Auditorium

Food Engineering

Chairman: EDWARD SELTZER
Thomas J. Lipton, Inc.

8:40— 62. Principles of Industrial Engineering in a Frozen Food Plant
CHARLES CALLEROS, Sacramento Freezers, Inc.

9:00— 63. Economic Efficiency in Food Plant Operations
R. G. BRESSLER, Univ. of Calif., Berkeley

9:20— 64. The Military Looks at Freeze Dehydration Economics and Engineering
RAYMOND R. HAUGH and F. P. MEHRLICH, Quartermaster Food and Container Institute for the Armed Forces

9:40— 65. Economic-Engineering Research in Food Processing Plants
B. C. FRENCH and L. L. SAMMET, Univ. of Calif., Davis and Berkeley

10:00— 66. The Extension Service as an Aid to Management
ERIC THOR, Univ. of Calif., Berkeley

10:20— 67. Recent Advances in Automation in Wholesale Bakery Operations
J. A. ABBOTT, Food Machinery & Chemical Corp

10:40— 68. Comparative Costs of Fruit Juice and Puree Drying Processes
G. BARD, W. CONLEY and F. FIXARI, Chain Belt Co.

11:00— 69. Operational Factors Influencing the Efficiency of Freeze Drying
M. C. BROCKMANN and J. M. TUOMY, Quartermaster Food & Container Institute for the Armed Forces

11:20— 70. Foam-Mat Drying of Orange and Tomato
A. I. MORGAN, R. P. GRAHAM, L. F. GINNETT and G. S. WILLIAMS, Western Regional Research Lab., U.S.D.A.

11:40— 71. Pure Vital Wheat Protein (Gluten)
JAMES G. MOORE, Blaw-Knox Co.

TUESDAY MORNING—MAY 17

Section B—Room 3-4

Fruit Products

Chairman: J. E. BREKKE
Western Regional Research Laboratory

8:40— 72. Further Studies on Effects of Gamma Radiation on Storage Life and Quality of Certain Fresh Fruits and Vegetables
D. K. SALUNKHE and MORRIS SIMON, Utah State Univ. and Quartermaster Food & Container Institute for the Armed Forces

9:00— 73. Quality of Mechanically Harvested Red Cherries
R. T. WHITTENBERGER, Eastern Regional Lab., U.S.D.A. and J. H. LEVIN, S. L. HEDDEN and H. P. GASTON, Michigan State University

9:20— 74. Factors Affecting the Quality of Candied Whole Kumquats
R. J. VILECE, Univ. of Florida

9:40— 75. Studies on the Drained Weight of Frozen Red Cherries
CLAUDE H. HILLS, E. C. DRYDEN and JAMES F. ROBINSON, Eastern Regional Research Lab., U.S.D.A.

10:00— 76. The Effect of Bruising on the Structure and Physical Properties of Red Cherries
M. L. BUCH and CLAUDE H. HILLS, Eastern Regional Research Lab., U.S.D.A.

10:20— 77. Spectrophotometric Determination of Sorbic Acid in Apple Cider
W. O. HARRINGTON, ANNE M. SMITH and CLAUDE H. HILLS, Eastern Regional Research Lab., U.S.D.A.

10:40— 78. Studies of Chemical Changes Associated with Deterioration of Domestic Dates
V. P. MAIER and FRANK H. SCHILLER, Fruit and Vegetable Chem. Lab., U.S.D.A.

11:00— 79. Evaluation of New Strawberry Varieties for Freezing and Preserving
E. R. WOLFORD, J. A. SACKLIN and C. D. SCHWARTZE, Western Regional Lab. and West Washington Experiment Station

11:20— 80. Factors Contributing to the Breakdown of Frozen Sliced Strawberries
WILLIAM A. SISTRUNK, ROBERT F. CAIN, EDWARD K. VAUGHAN and HARRY B. LAGERSTEDT, Oregon State College

11:40— 81. The Relationship of Apple Maturity to Applesauce Quality
ROBERT L. LABELLE, ROBERT S. SHALLENBERGER, LEONARD R. MATTICK and JAMES C. MOYER, N. Y. Agr. Exp. Station, Cornell Univ.

12:00— 82. Heating Patterns in Canned Berry Fruits During Still Processing
R. A. GALLOP and J. H. DIETZ, Oregon State College

TUESDAY MORNING—MAY 17

Section C—Room 5-6

Basic Research—Food Lipids

Chairman: BETTY WATTS
Florida State University

8:40— 83. Development and Inhibition of Oxidative Rancidity in Foods
L. R. DUGAN, JR., American Meat Institute Foundation

9:10— 84. Some Biological Aspects of Fat Deterioration
C. H. LEA, Low Temp. Research Station (England)

9:40— 85. The Fatty Acid Content of the Lipid of Spinach
LEONARD R. MATTICK and FRANK A. LEE, New York State Agr. Experiment Station

10:00— 86. Carbonyls in Oxidizing Fat. IV. The Role of Various Fatty Acid Components on Carbonyl Generation

REX ELLIS, A. M. GADDIS, G. T. CURRIE, Meat Lab., U.S.D.A.

10:20— 87. Autoxidation of Fish Oils. I. Identification of Volatile Monocarbonyl Compounds from Autoxidized Salmon Oil
T. C. YU, EDGAR A. DAY, RUSSELL O. SINNHUBER, Oregon State College

10:40— 88. The Effect of Methylation Upon the Antioxygenic and Chelating Capacity of Quercetin and Dihydroquercetin in a Lard Substrate
DAVID L. CRAWFORD, RUSSELL O. SINNHUBER, HARVEY AFT, Oregon State College and Oregon Forest Research Center

11:00— 89. Oxidation of Fat in Model Systems Related to Dehydrated Foods. II. Position of Dispersed Lipid Components and Its Effect on Oxidation Rates
S. J. BISHOV, A. S. HENICK and ROBERT B. KOCH, Quartermaster Food and Container Institute for the Armed Forces

11:20— 90. Hematin Catalyzed Unsaturated Lipid Peroxidation and Its Inhibition by Vitamin E
A. L. TAPPEL, H. ZALKIN and F. W. KNAPP, Univ. of Calif., Davis

11:40— 91. Properties of Lipids that Influence Stability of Salad Dressing Type Emulsions Subjected to Freezing
HELEN L. HANSON, LORRAINE R. FLETCHER and LEO KLINE, Western Regional Research Lab., U.S.D.A.

12:00— 92. Effect of Ionizing Radiation on the Fat-Soluble Vitamins
F. W. KNAPP and A. L. TAPPEL, Univ. of California, Davis

TUESDAY MORNING—MAY 17

Section D—Room 7-8

Fish, Meat and Poultry

Chairman: J. R. VICKERY
CSIRO (Australia)

8:40— 93. Chemical Studies on the Aging of Meats
MASAO FUJIMAKI and NOBUHIKO ARAKAWA, Univ. of Tokyo (Japan)

9:00— 94. Development of Freezer-Burn as a Limiting Factor in the Storage of Animal Tissue. III. Additional Treatments to Control Freezer-Burn (on Frozen Offals)
G. KAESS and J. R. VICKERY, CSIRO (Australia)

9:20— 95. Proteolytic Changes in Stored Beef. VI. Effect of Pre-Irradiation Heating Temperature and Irradiation Level
R. H. THOMPSON, FLOR R. BAUTISTA and R. F. CAIN, Oregon State College

9:40— 96. Proteolytic Enzyme Activity During Storage of Radiation-Stabilized Raw Beef and Its Significance to Flavor
MAURICE P. DRAKE, GERALD D. GERNON, JR. and FRED J. KRAUS, Quartermaster Food and Container Institute for the Armed Forces

10:00— 97. The Effectiveness of Acronize Chlortetracycline in Poultry Preservation Following Long Term Commercial Use
A. ABBEY, A. R. KOHLER and P. F. HOPPER, American Cyanamid Co.

10:20— 98. Studies on the Room Temperature Aging of Beef Following Intravenous Ante-Mortem Injection of Acronize Chlortetracycline
M. C. FIRMAN, A. ABBEY, A. R. KOHLER and P. F. HOPPER, American Cyanamid Co.

10:40— 99. Effect of Pre-Irradiation Heating on the Flavor and Nitrogenous Constituents of Beef During Storage
ORHAN G. ARTAR, JEROME C. R. LI and R. F. CAIN, Oregon State College

11:00—100. Time and Temperature Tolerances in Frozen Beef and Pork
H. D. NAUMANN and J. L. McBEE, JR., Univ. of Missouri

11:20—101. Stability Factors in Packaged Raw Meat
C. OLIN BALL, Rutgers University

11:40—102. The Effect of an Antioxidant in the Hog Ration on the Storage Life of Pork and Lard
DOROTHY L. HARRISON, J. L. HALL and D. L. MACKINTOSH, Kansas State University

TUESDAY AFTERNOON—MAY 17

General Session

MASONIC TEMPLE AUDITORIUM

Chairman: R. B. WAKEFIELD, President, I.F.T.

1:30— Babcock-Hart Award Address

Concurrent Sessions

Section A—Auditorium

Food Engineering

Chairman: R. L. BAKER
Pennsylvania State University

2:20—103. Sterilization of Processing Facilities
FRANK A. BELLATO, Thermovac, Inc.

2:40—104. Fouling of Heat Exchanger Tubes
A. I. MORGAN and R. A. CARLSON, Western Regional Research Lab., U.S.D.A.

3:00—105. Studies on the Application of Infrared in Food Processing
E. A. ASSELBERGS, W. P. MOHR and J. G. KEMP, Plant Research Institute, Dept. of Agriculture (Canada)

3:20—106. Dehydrofrozen Apples: Recent Developments in Processing Methods
M. E. LAZAR, G. S. SMITH and E. O. CHAPIN, Western Regional Research Lab., U.S.D.A.

3:40—107. Yield Characteristics of Selected Food Items Prepared by Microwave and Conventional Cooking Equipment
GEORGE A. POLLAK and LOUISE C. FOIN, U. S. Naval Supply Research and Development Facility

4:00—108. Comparative Heating Efficiencies of a Microwave Oven and a Conventional Electric Oven

GEORGE A. POLLAK and LOUISE C. FOIN, U. S. Naval Supply Research and Development Facility

4:20—109. Thermal Properties of Foods at Low Temperatures: I. Specific Heat

S. W. MOLINE, J. A. SAWDYE, A. J. SHORT and A. P. RINFRET, Linde Co. Div., Union Carbide Corp.

4:40—110. A Method for Calculating the Temperature Distribution and Mass Average Temperature in Conduction-Heated Canned Foods During Water Cooling

STANLEY CHARM, Massachusetts Institute of Technology

5:00—111. Continuous Process Data Recording in the Manufacture of Vegetable Fat Whipping Emulsions

H. W. DIAMOND, Rich Products Corp.

5:20—112. A Mechanical Poultry Meat Extractor

STERLING G. HARRIS, STANLEY E. WASKIEWICZ and WALTER A. ZACHOWSKI, Blue Channel Corp.

TUESDAY AFTERNOON—MAY 17

Section B—Room 3-4

Citrus Products

Chairman: C. H. BROKAW
Minute Maid Corporation

2:20—113. The Viability of a Yeast in High Density Orange Concentrates Stored at Various Temperatures

ROBERT L. KITCHEL and MARTIN W. MILLER, Sunkist Growers and Univ. of Calif., Davis

2:40—114. Moisture Formation in Dehydrated Lemonade

WILLIAM K. HIGBY, Sunkist Growers

3:00—115. Investigations of the Hydrocarbons in Lemon Oil

R. M. IKEDA, W. L. STANLEY and SUSAN COOK, Fruit & Vegetable Chem. Lab., U.S.D.A.

3:20—116. Gas Chromatographic Analysis of the Major Aldehydes in Lemon, Orange and Grapefruit Oils

W. L. STANLEY, R. M. IKEDA, S. H. VANNIER and L. A. ROLLE, Fruit & Vegetable Chem. Lab., U.S.D.A.

3:40—117. The Carbohydrates of Citrus Peel

S. V. TING and E. J. DESZYCK, Florida Citrus Commission and Citrus Exp. Station

4:00—118. A Rapid Method for the Determination of Oxygen in Orange Juice

J. A. BRENT, J. A. McGOUYRK and G. RAO, Minute Maid Corp.

4:20—119. An Ion-Exchange Study of the Amino Acids in Citrus Fruits

ROBERT L. CLEMENTS, Univ. of Calif., Riverside

4:40—120. The Determination of Soluble Solids in Citrus Juices. I. The Effect of Non-Sucrose Constituents on Refractometer Values

W. CLIFFORD SCOTT, DONALD A. MORGAN and M. K. VELDHUIS, Fruit & Vegetable Products Lab., U.S.D.A.

5:00—121. Consumer Opinion of Sweeteners in Frozen Concentrated Lemonade and Orange Juice Drink

ROSE MARIE PANGBORN, G. L. MARSH, W. R. CHANNEL and H. CAMPBELL, Univ. of Calif., Davis

TUESDAY AFTERNOON—MAY 17

Section C—Room 7-8

Basic Research—Food Proteins

Chairman: M. L. ANSON
(England)

2:40—122. Wheat Gliadin in Foams for Food Products

C. E. McDONALD and J. W. PENCE, Western Regional Research Lab., U.S.D.A.

3:00—123. Myoglobin

J. B. NEILANDS, Univ. of Calif., Berkeley

3:20—124. Milk Proteins

N. J. HIPP and T. L. McMEEKIN, Eastern Regional Research Lab., U.S.D.A.

3:40—125. Properties and Food Uses of Soybean Protein

ALLAN K. SMITH and WALTER J. WOLF, Northern Regional Research Lab., U.S.D.A.

4:00—126. Gel Electrophoresis and Its Application to Analysis of the Caseins

R. G. WAKE and R. L. BALDWIN, Stanford University

4:20—127. The Egg-White Proteins. Their Roles in the Properties of Eggs and Egg Products

ROBERT E. FEENEY, Univ. of Nebraska

4:40—128. Damage to Proteins and Amino Acids by Ionizing Radiation

K. S. AMBE, A. L. TAPPEL, P. MARKAKIS and R. ROMANI, Univ. of Calif., Davis

TUESDAY AFTERNOON—MAY 17

Section D—Room 5-6

Fish, Meat and Poultry

Chairman: H. L. A. TARR
Pacific Fisheries Experimental Station (Canada)

2:40—129. Antibiotic Residues and Keeping Quality of Pork Resulting from the Intravenous Ante-Mortem Injection of Acronize Chlortetracycline

A. R. KOHLER, A. ABBEY, M. C. FIRMAN and P. F. HOPPER, American Cyanamid Co.

3:00—130. Chemical Control of Microbial Spoilage in Frankfurters

G. ROBERT DiMARCO, HENRY J. IZZO and ROY E. MORSE, Rutgers University

3:20—131. Preparation and Storage Characteristics of Freeze-Dried Sausages. I. Formulation and Processing of Comminuted Sausages (Frankfurters)

HUSSEIN O. A. OSMAN and ROY E. MORSE, Rutgers University

3:40—132. Preparation and Storage Characteristics of Freeze-Dried Sausage. II. Emulsion Stabilization and Rate of Freeze-Drying in Comminuted Sausages (Frankfurters)

HUSSEIN O. A. OSMAN and ROY E. MORSE, Rutgers University

4:00—133. An Accelerated Oxidization Method for the Estimation of the Storage Life of Frozen Seafoods

ROBERT E. PALMATEER, T. C. YU and RUSSEL O. SINNHUBER, Oregon State College

4:20 134. The Prevention of Blue Discoloration of Canned Crab Meat by Fractional Coagulation and Low Temperature Cooking Methods

ISAMI OSAKABE, Tokyo Univ. of Fisheries (Japan)

4:40—135. Formation of Acetoin in Cod Fillets During Refrigerated Storage

HERMAN S. GRONINGER, JR., U. S. Fish and Wildlife Service

5:00—136. Studies on the Estimation of the Storage Life of Raw Fishery Products

PETER LERKE and LIONEL FARBER, Univ. of Calif., San Francisco

WEDNESDAY MORNING—MAY 18

Concurrent Sessions

Section A—Masonic Temple Auditorium

Quality Control—Instrumentation

Chairman: AMIHUD KRAMER
University of Maryland

8:40—137. Standardized Color Measurements of Food Products

RICHARD S. HUNTER, Hunter Associates Lab.

9:00—138. Nondestructive Measurement of Quality Factors by Light Transmittance

KARL H. NORRIS, Agr. Mktg. Service, U.S.D.A.

9:20—139. Food Textural Measuring Instruments and Their Standardization and Calibration

BERNARD A. TWIGG, Univ. of Maryland

9:40—140. Use of Gas Chromatography in Flavor Quality Control

WILLIAM H. STAHL, McCormick & Co.

10:00—141. Automatic Control of a Rotary Piston Filling Machine by a Nuclear Fill Level Measuring System

ROBERT A. KNAPP and DOUGLAS W. SCHAFROTH, Industrial Nucleonics Corp.

10:20—142. Standardization of Coffee Color Measurement

ERNEST E. LOCKHART, Coffee Brewing Institute

Statistical Quality Control

10:40—143. Optimum Sampling Procedures for Raw Products

GORDON A. ROWE, Univ. of Calif., Berkeley

11:00—144. A Graphic Sequential Sampling Procedure for Mold Count Determination

NORMAN A. OLSON and GORDON A. ROWE, Natl. Canners Assoc. and Univ. of Calif., Berkeley

11:20—145. Statistical Quality Control Techniques in Canning Plants

NORMAN E. LILES, Tri-Valley Packing Assoc.

11:40—146. Quick Rank Tests for Determining Statistically Significant Differences

AMIHUD KRAMER, Univ. of Maryland

WEDNESDAY MORNING—MAY 18

Section B—Room 3-4

Vegetable Products

Chairman: C. T. TOWNSEND
National Canners Association

8:40—147. Color and Enzyme Inactivation of Processed Peas

H. W. ADAMS and E. S. YAWGER, Food Machinery & Chemical Corp.

9:00—148. Degradation of Chlorophyll Derivatives in Acid Solutions

S. SCHANDERL, C. O. CHICHESTER and G. L. MARSH, Univ. of Calif., Davis

9:20—149. Effect of Iodized Salt on the Detinning of Cans by Green Beans

A. A. KOPETZ and L. T. ROBERTS, American Can Co.

9:40—150. Optical Density of Tomato Concentrates as a Measure of Heat Induced Changes in Product Corrosivity

HARLEY H. HERNANDEZ and JAMES F. FEASTER, American Can Co.

10:00—151. Effect of Packaging Films and Storage Temperatures on the Ripening of Mature Green Tomatoes

JOHN C. AYRES and LINCOLN C. PEIRCE, Iowa State University

10:20—152. Effect of Sodium Chloride, Citric Acid and Sucrose on pH and Palatability of Canned Tomatoes

SHERMAN LEONARD, B. S. LUH, and ROSE MARIE PANGBORN, Univ. of Calif., Davis

10:40—153. Effect of Harvest Maturity on Consistency of Canned Tomato Juice

B. S. LUH, FIDEL VILLARREAL, S. J. LEONARD and M. YAMAGUCHI, Univ. of Calif., Davis

11:00—154. Factors Influencing pH Values of Processed Tomatoes

HAROLD W. ADAMS, Food Machinery & Chemical Corp.

11:20—155. Low Temperature Handling of Sterilized Foods. II. The Storage Stability of the Color

of High Temperature Short Time Sterilized Green Peas

A. I. EPSTEIN, E. F. STIER and C. OLIN BALL, Rutgers University

11:40—156. Low Temperature Handling of Sterilized Foods. IV. The Effects of Storage Temperature on the Quality of Frozen and of HTST and Conventionally Sterilized Canned Vegetables, Soup, and Evaporated Milk.

A. I. EPSTEIN, G. J. LAURO, E. F. STIER and C. OLIN BALL, Rutgers University

WEDNESDAY MORNING—MAY 18

Section C—Room 5-6

Fish, Meat and Poultry

Chairman: W. J. STADELMAN
Purdue University

8:40—157. Influence of Freezing and Thawing and Freeze Dehydration on the Hydration and Charges of Meat Proteins

REINER HAMM and F. E. DEATHERAGE, Ohio State University

9:00—158. Emulsion Formation in Finely Comminuted Sausage

LEO J. HANSEN, Oscar Mayer & Co.

9:20—159. Determination of Meat Swelling as a Method for Investigating the Water-Binding Capacity of Muscle Proteins with Low Water-Holding Forces

EUGEN WIERBICKI, MILTON G. TIEDE and GLENN COOPER, Rath Packing Co.

9:40—160. Tendered Meat Through Antemortem Vascular Injection of Proteolytic Enzymes

P. A. GOESER, H. F. BERNHOLDT, M. HOGAN and G. E. BRISSEY, Swift & Co.

10:00—161. Tenderness and Chemical Composition of Beef. I. Variations Among Animals Treated Alike

PAULINE C. PAUL, Univ. of Calif., Davis

10:20—162. Variations and Their Causes in the Measurement of Beef Tenderness by the Electric Grinder Method

C. M. SCHOMAN, JR., J. BELL and C. OLIN BALL, U. S. Naval Supply Research & Development Facility and Rutgers Univ.

10:40—163. Biochemical Factors Affecting Beef Tenderness

N. B. WEBB, O. J. KAHLENBERG and H. D. NAUMANN, Univ. of Missouri and Michigan State Univ.

11:00—164. A Comparison of Objective Physical Measurements to Determine Meat Tenderness

H. D. NAUMANN, J. D. VOLK, N. B. WEBB and J. L. McBEE, JR., Univ. of Missouri

11:20—165. The Tenderization Pattern in Adrenaline-Treated Poultry

DONALD DE FREMERY and MORRIS F. POOL, Western Regional Research Lab., U.S.D.A.

11:40—166. Consumer Acceptability of Boneless Carcass Beef

H. D. NAUMANN, V. J. RHODES, D. C. BUBACK, and TAYLOR HENDRICKSON, Univ. of Missouri

WEDNESDAY MORNING—MAY 18

Section D—Room 7-8

Radiation Preservation of Food

Chairman: C. F. SCHMIDT
Continental Can Co.

CONTRIBUTED PAPERS

8:40—167. Radiation Sterilization of Food. Part II. Some Aspects of Growth, Sporulation and the Radiation Resistance of Spores of *Clostridium botulinum* Type E

C. F. SCHMIDT, W. K. NANK and R. V. LECHOWICH, Continental Can Co.

9:00—168. Effect of Electron Radiation on Survival of *Bacillus stearothermophilus* at Various Depths of Penetration in Agar

JUNE E. POSTWEILER and ELWOOD F. CALDWELL, Quaker Oats Co.

9:20—169. Radioresistance of Five Strains of *Clostridium botulinum* in Selected Food Products

E. WHEATON, G. B. PRATT and J. M. JACKSON, American Can Co.

9:40—170. Irradiation Resistance of the Natural Bacterial Flora of Cured Ham

W. L. BROWN, C. A. VINTON and C. E. GROSS, John Morrell & Co.

10:00—171. The Effect of Additives on Radiation—Resistance of *Clostridium botulinum* in Meat

A. W. ANDERSON, R. F. CAIN and P. R. ELLIKER, Oregon State College

10:20—172. The Effect of Beta Irradiation and Chlortetracycline on the Microbial Flora of Fish and Shellfish

PETER LERKE, LIONEL FARBER and WOLFGANG HUBER, Stanford Univ. and Univ. of Calif., San Francisco

SYMPOSIUM

Chairman: C. F. SCHMIDT
Continental Can Company

SYMPOSIUM PAPERS

10:40—173. The Objectives of the Quartermaster Food and Container Institute for the Armed Forces Radiation Research Program

HARRY E. GORESLINE, Quartermaster Food & Container Institute

10:55—174. Dose Requirements for the Radiation Sterilization of Food

W. E. PERKINS, National Canners Association; C. F. SCHMIDT, Continental Can Co.; A. W. ANDERSON, Oregon State College

11:40—175. Radiation Pasteurization of Food

DOROTHY ANN HUBER, Quartermaster Food & Container Institute for the Armed Forces

11:55—176. British Viewpoint on the Radiation Preservation of Food

M. INGRAM, Low Temp. Research Station (England)

12:10— Discussion

WEDNESDAY AFTERNOON—MAY 18

General Session

Masonic Temple Auditorium

Chairman: RAY WAKEFIELD, President, I.F.T.

1:30— Nicholas Appert Award Address

2:10— Business Meeting

Concurrent Sessions

Section A—Auditorium

Quality Control

Chairman: AMIHUD KRAMER
University of Maryland

2:40—177. Simplified Procedures for Evaluating Taste Panel Data
H. L. STIER, Natl. Canners Assoc.

3:00—178. The Effect of Number of Judgments in a Test on Flavor Evaluation for Preference
LOIS A. SATHER and LYLE D. CALVIN, Oregon State College

3:20—179. Sensory Evaluation of Accessory Foods with and Without Carriers
BEVERLEY J. KROLL and FRANCIS J. PILGRIM, Quartermaster Food and Container Institute for the Armed Forces

3:40—180. Monotony Characteristics of Foods
JOSEPH M. KAMEN and DAVID R. PERYAM, Quartermaster Food and Container Institute for the Armed Forces

4:00—181. Analysis of Some Common Insecticides by Gas Chromatography
K. P. DIMICK, C. B. ABMA and T. Z. CHU, Wilkens Instrument & Research, Inc.

Vegetable Products

Chairman: C. T. TOWNSEND
National Canners Association

4:20—182. Low-Temperature Handling of Sterilized Foods. V. Biochemical Changes in Storage
AARON L. BRODY, KARAKIAN BEDROSIAN and C. OLIN BALL, Whirlpool Corp. and Rutgers University

4:40—183. Time-Temperature Tolerance of Frozen Foods. Quality Changes in Cauliflower
W. C. DIETRICH, MARVEL-DARE NUTTING, MILDRED M. BOGGS and N. E. WEINSTEIN, Western Regional Research Lab., U.S.D.A.

5:00—184. Changes in Soybean Lipids During the Tempeh Fermentation
A. C. WAGENKNECHT, L. R. MATTICK, L. M. LEWIN, K. H. STEINKRAUS and D. B. HAND, N. Y. Agr. Exp. Station, Cornell University

5:20—185. Investigations of the Equivalent Weights of Dehydrated Diced Potatoes and Dehydrated Sliced Onions in Comparison to Their Fresh Counterparts
H. R. IGNALL, U. S. Naval Supply, Research and Development Facility

WEDNESDAY AFTERNOON—MAY 18

Section B—Room 3-4

Basic Research—Flavor Chemistry

Chairman: HANS LINEWEAVER
Western Regional Research Laboratory, U.S.D.A.

2:40—186. Volatiles Contributing to the Flavor of Bartlett Pears
W. G. JENNINGS, S. LEONARD and R. M. PANGBORN, Univ. of Calif., Davis

3:00—187. Separation and Identification of Cooked Beef Flavor Components
W. E. KRAMLICH and A. M. PEARSON, Michigan State University

3:20—188. Citrus Flavor. Volatile Constituents of the Essential Oil of the Orange (Citrus Sinensis)
RICHARD A. BERNHARD, Univ. of Cailf., Davis

3:40—189. A Study of Beef Irradiation Flavor by Means of Concurrent Radiation-Distillation
J. E. HOFF, E. L. WICK, B. E. PROCTOR and S. A. GOLDBLITH, Massachusetts Institute Technology

4:00—190. The Production of Irradiated Odors from Beef Protein Fractions and Their Derivations
P. A. HEDIN, G. W. KURTZ and ROBERT B. KOCH, Quartermaster Food & Container Institute for the Armed Forces

4:20—191. Maple Sirup. XVI. The Isolation and Identification of Compounds Contributing to the Flavor of Maple Sirup
J. C. UNDERWOOD, C. O. WILLITS and HARRY G. LENTO, Eastern Regional Research Lab., U.S.D.A.

WEDNESDAY AFTERNOON—MAY 18

Section C—Room 5-6

Fish, Meat and Poultry

Chairman: J. R. WHITAKER
University of California, Davis

2:40—192. Beef Quality as Affected by Delayed Growth Due to Protein Deficiency
MARION SIMONE, F. D. CARROLL, C. O. CHICHESTER and J. R. WHITAKER, Univ. of Calif., Davis

3:00—193. Variations in Marbling, Cooking Yield and Eating Quality of Pork Chops from Meat-Type and Fat-Type Hogs
MINERVA MURPHY and AGNES FRANCES CARLIN, Iowa State University

3:20—194. Some Factors Associated with Tenderness of Poultry Meat
W. J. STADELMAN, Purdue University

3:40—195. Some Biochemical Changes Occurring in Experimentally Inflicted Poultry Bruises
M. K. HAMDY, J. J. POWERS and K. N. MAY, Univ. of Georgia

4:00—196. Effect of Ascorbate on Healing of Poultry Bruises
M. K. HAMDY, A. J. DESMARAIS, K. N. MAY, J. J. POWERS and D. E. PRATT, Univ. of Georgia

4:20—197. Taste Panel Evaluation of Chickens Fed Different Levels of Peanut Oil Meal, Methionine and Lysine

R. J. VILECE, Univ. of Florida

4:40—198. A New and Useful Chelating Agent for Preserving the Natural Color of Marine Products, Meats and Vegetables

CARL R. FELLERS, M. S. CHAN and S. S. YANG, Univ. of Mass.

WEDNESDAY AFTERNOON—MAY 18

Section D—Room 7-8

Microbiology and Public Health

Chairman: W. S. OGILVY
Mead Johnson & Co.

2:40—199. Comparative Studies on Media for Counting Anaerobic Bacterial Spores II.

E. WHEATON and G. B. PRATT, American Can Co.

3:00—200. Thermal Resistance of *Clostridium sporogenesis* (PA 3679) at the Intermediate pH Range

KIYOSHI TSUJI, HAMED M. EL-BISI and WILLIAM B. ESSELEN, Univ. of Massachusetts

3:20—201. Low Temperature Handling of Sterilized Foods III. Medium for Establishing Requirements for Sporulation by a *Clostridium*

GABRIEL J. LAURO, C. O. BALL and ROY E. MORSE, Rutgers University

3:40—202. Nutritional Studies on *Lactobacillus heterohiochi*. An Organism Causing Spoilage of Japanese Rice Wine (Sake)

A. L. DEMAIN, E. L. RICKES, D. HENDLIN and E. C. BARNES, Merck & Co.

4:00—203. Defrost Temperatures of Some Prepared Frozen Foods and the Effect of Defrost Conditions on Microbiological Populations

M. J. FANELLI and M. F. GUNDERSON, Campbell Soup Co.

4:20—204. Activity of a Psychrophile and Its Cell-Free Enzymes on Certain Components of Frozen Meat Pies

A. C. PETERSON and M. F. GUNDERSON, Campbell Soup Co.

4:40—205. Action of Anthocyanin Pigments and Related Compounds on Growth of Certain Microorganisms

J. J. POWERS, D. SOMAATMADJA, D. E. PRATT and M. K. HAMDY, Univ. of Georgia

5:00—206. In Vitro Effects of Chlortetracycline on Bacteria Indigenous to Gulf Shrimp and Oysters

ARTHUR F. NOVAK, K. G. STOLZLE and ERNEST A. FIEGER, Louisiana State University

5:20—207. Analysis of Headspace Gases in Canned Foods by Gas Chromatography

D. C. VOSTI, H. H. HERNANDEZ and J. B. STRAND, American Can Co.

PACIFIC RIM FOOD CONFERENCE

Headquarters: Princess Kaiulani Hotel
Honolulu, Hawaii

FRIDAY—MAY 20

9:00 A.M.—Orientation Session

Program Chairman: R. M. Heinicke, Hawaiian Pineapple Co. (Hawaii)

9:30 A.M.-4:30 P.M.—Technical tours of pineapple and sugar cane plantations and processing plants on Oahu

SATURDAY—MAY 21

9:00 A.M.-4:30 P.M.—Technical tour of tropical fruit production areas in Hilo

MONDAY—MAY 23

9:00 A.M.-3:00 P.M.—Technical tour of coffee plantation and processing plant on Hilo

TUESDAY MORNING—MAY 24

Concurrent Technical Sessions

Section A—Princess Kaiulani Hotel

Tropical Fruits, Nuts and Coffee

Chairman: I. J. HUTCHINGS
President-Elect, I.F.T.

8:30—Mangoes

Discussion Leader: H. KAMEMOTO, University of Hawaii (Hawaii)

9:15—Tropical Nuts

Discussion Leader: E. H. BEAVENS, Fruit and Vegetable Chem. Lab., U. S. Dept. Agric. (California)

10:15—Pineapples

Discussion Leader: R. L. CUSHING, Pineapple Research Institute (Hawaii)

11:00—Coffee

Discussion Leader: F. MEHRLICH, Quartermaster Food and Container Institute for the Armed Forces (Illinois)

Section B

Cereals

Chairman: J. W. PENCE
Western Regional Research Laboratory, U.S.D.A.

8:30—Food Protein Problems of the Far East

M. L. ANSON (England)

9:20—Bulgur Wheat and Its Export Potential for the Use

Discussion Leader: WILLIAM L. HALEY, Fisher Flouring Mills, Seattle, Washington

10:00—Wheat Gluten, a Protein Concentrate for Food

Discussion Leader: ROHLAND S. SHUMARD, Hercules Powder Co. (Delaware)

10:45—Indigenous Cereals as Protein Sources for People of Rim Countries

Speaker to be announced

TUESDAY AFTERNOON—MAY 24

Section A

Tropical Fruits and Fruit Products

Chairman: G. E. FELTON

Hawaiian Pineapple Company (Hawaii)

1:15—Acerola Cherries

H. Y. NAKASONE, University of Hawaii

2:00—Guava

Discussion Leader: FRANK BOYLE, Hawaiian Pineapple Co. (Hawaii)

3:00—Passion fruit

Discussion Leader: J. R. VICKERY, Comm. Sci. Ind. Res. Organ. (Australia)

4:00—Papaya

Discussion Leader: W. B. STOREY, University of California, Riverside (California)

Section B

Poultry Meat

Chairman: G. F. STEWART

University of California, Davis (California)

1:15-4:00—Panel Discussion: Technical and Economic Problems of Increasing Trade in Poultry Meat Among Rim Countries

J. C. ABBOTT, Food and Agric. Organ., United Nations (Rome)

S. GOTO, Goto Hatchery (Japan)

C. CARPENTER, Carpenter Associates (California)

J. R. VICKERY, Comm. Sci. Ind. Res. Organ. (Australia)

H. LINEWEAVER, Moderator, Western Regional Research Laboratory, U.S.D.A. (California)

WEDNESDAY MORNING—MAY 25

Section A

Tropical Fruit and Spice Products

Chairman: H. T. COOK

Agricultural Marketing Service, U.S.D.A. (Wsahington, D.C.)

8:30—Litchi

Discussion Leader: Y. B. GOTO, University of Hawaii (Hawaii)

9:15—Panel Discussion: Other Tropical Plant Products

Y. B. GOTO, Moderator, University of Hawaii (Hawaii)

10:15—Citrus Products

Discussion Leader: K. HIRANO, Canner's Assoc. (Japan)

11:00—Pepper and Other Spices

Discussion Leader: R. H. VAUGHN, University of California, Davis (California)

Section B

Fish and Meat Products

Chairman: H. LINEWEAVER

Western Regional Research Laboratory, U.S.D.A. (California)

8:30—Fish

Discussion Leaders:

I. OSAKABA, Tokyo University of Fisheries (Japan)

H. L. A. TARR, Pacific Fisheries Experimental Station (Canada)

10:00—Panel Discussion: Technical and Economic Problems of Increasing Trade in Beef, Lamb, and Pork Products

M. FUJIMAKI, University of Tokyo (Japan)

G. L. MEHREN, University of California, Berkeley (California)

J. C. ABBOTT, Food and Agric. Organ., United Nations (Rome)

J. R. VICKERY, Moderator, Comm. Sci. Ind. Res. Organ. (Australia)

WEDNESDAY AFTERNOON—MAY 25

Plenary Session

Chairman: R. B. WAKEFIELD

President, I.F.T.

1:15—General Transportation and Storage Problems

Discussion Leader: H. T. COOK, Agric. Marketing Service, U.S.D.A. (Washington, D.C.)

2:00—Panel Discussion: Increasing Food Production and Processing in Asian Countries

J. C. ABBOTT, Food and Agric. Organ., United Nations (Rome)

A. G. VAN VEEN, Food and Agric. Organ., United Nations (Rome)

3:00—Trade Barriers

Discussion Leader: G. L. MEHREN, University of California, Berkeley (California)

4:00—Conference Summation

Discussion Leaders:

W. A. GORTNER, Pineapple Research Institute (Hawaii)

G. F. STEWART, University of California, Davis (California)

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ABSTRACTS

San Francisco Session Papers

1

RECENT PROGRESS IN THE CONSIDERATION OF FLAVORING INGREDIENTS UNDER THE FOOD ADDITIVES AMENDMENT

RICHARD L. HALL
McCormick & Company, Inc., 414 Light Street
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Flavoring ingredients pose particularly vexing problems under the Food Additives Amendment because of their variety, importance, complexity, low levels of use, and generally small annual volume. Procedures adopted by the flavor industry to comply with the new amendment will be reviewed, and the results obtained will be discussed with reference to specific examples. Some implications for other food ingredients will be considered.

2

FOOD COLORS—THEIR STATUS UNDER THE LAW

ARTHUR T. SCHRAMM
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The Food Additives Amendment of 1958 excluded from its provisions color additives use of which has been authorized under Section 406(b) of the Federal Food, Drug, and Cosmetic Act since 1938. These so called "coal-tar" colors were originally admitted to listing on the basis of requirements much the same as those recently promulgated for food additives. However, Section 406(b) fails to provide administrative authority for prescribing levels of use. Proposed legislation, S. 2197 which would spell out such authority, has already passed the Senate and is now awaiting consideration by the House of Representatives. The major issue in the bill is the so-called Delaney cancer clause which was omitted in the Senate Bill. Other matters which will be discussed include Food and Drug Administration's activities in this field.

3

AN ORGANIC CHEMIST'S APPROACH TO SOME PROBLEMS RAISED BY THE FOOD LAW AMENDMENT

L. E. SCHNIEPP, H. O. ETIAN, and J. M. JACKSON
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Barrington, Illinois

The extensive use of polymeric organic materials as coatings and sealants for food containers necessitates the development of specialized techniques to determine if any components of these materials are migrating into the food product. The training and experience of the organic chemist are needed to devise methods for the separation and analysis of such materials. To find trace amounts of specific materials in such complex mixtures as foods requires a knowledge of the solubilities and reactive group characteristics of the materials in question. Some of the problems encountered and the approach to their solution will be discussed.

4

BIOLOGICAL SCREENING TECHNIQUES FOR FOOD ADDITIVES

MARGARET IVES and EDYTHE M. NAGLER
American Can Company
Barrington, Illinois

The concept of biological screening studies performed early in the development of new materials for food use to determine the degree of toxicity will be presented. The basic test involves a 90-day period of rat feeding. If the material proves to have subacute toxicity at relatively low levels of intake, two-year studies with rats and dogs (or monkeys) and the development of analytical procedures will be required to set tolerances under the new Food Additives Amendment. Should the expenses to be incurred with these tests be greater than the value of the development, work may be stopped after the 90-day feeding study to avoid further financial outlay. These 90-day screening tests include observations on growth rates, food consumption, complete blood studies, necropsy and statistical evaluation of all data obtained from the rat experiments.

5

A SYSTEM FOR APPLICATION OF THE FOOD AND DRUG ACT (AS AMENDED) IN A MULTI-PLANT, MULTI-PRODUCT FOOD COMPANY

ZENAS BLOCK, PAUL KHAN, and PAULINE GOLDMAN
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A system is described for raw materials selection, proper terminology, maintenance of current status, and application of information to a multi-product, multi-plant food company with a great variety of products which frequently change in composition.

Methods and forms for accumulating, presenting, tabulating and systematizing information are given.

Organizational procedure for executing the procedure is described.

6

ANTIBIOTIC PRESERVATION OF BEEF WITH SUBSEQUENT FEEDING TO EXPERIMENTAL ANIMALS

R. B. SLEETH, J. C. ARMSTRONG, H. S. GOLDBERG, and H. D. NAUMANN
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It has been ascertained that organoleptic characteristics of high temperature aged beef were comparable to beef aged in the conventional manner. However, in some instances, beef aged at high temperatures had a tendency to develop microbial growth on the surface along with some deep seated spoilage. Antibiotics have been suggested as a means of controlling spoilage of beef during aging at high temperatures.

Twenty Standard and Utility cattle were injected intramuscularly with oxytetracycline at the rate of 0.80 mg per lb of body weight 30 minutes to 6 hours antemortem. Samples of blood, urine, and various tissues were taken at time of slaughter for bioassay.

After slaughter, the right side of each carcass was placed directly into an 86° F aging room without chilling and held 48 hours under controlled environmental conditions. Sides were sprayed with a combination of 10 or 20 ppm solution of OTC and/or 20 ppm nystatin and sorbic acid. The left side was held 15 days (control) at 36° F. A combination of 20 ppm OTC and 20 ppm nystatin was more effective in reducing total surface microflora than a similar combination of oxytetracycline and sorbic acid.

Raw and cooked meat containing low levels of OTC, when fed over a period of 12 weeks, did not cause any detectable residual in blood serum, heart, kidney, or muscle of rats. Evaluation of the emergence of OTC resistance of enteric flora revealed no significant difference between organisms from control and antibiotic fed rats.

7

CHARACTERISTICS OF BROWNING ENZYMES IN FAY ELBERTA FREESTONE PEACHES

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The characteristics and properties of polyphenolase and peroxidase from Fay Elberta peaches were investigated. These include optimum pH, Michaelis constant, substrate specificity, inhibition and enzyme stability.

A pH optimum of 4.6–4.8 in citrate-phosphate buffer, with guaiacol as substrate was found for peroxidase. In the same buffer, polyphenolase, with catechol as substrate, exhibited a pH optimum of 5.9 to 6.3. Michaelis constants of 0.12 M catechol and 0.010 M guaiacol are reported for polyphenolase and peroxidase. Both enzymes act primarily upon the ortho-dihydroxy configuration. The para-dihydroxy structure was also oxidized by both enzymes, but at a slower rate. Neither enzyme exhibited significant activity with the monohydroxy and meta-dihydroxy compounds as substrates. Sodium diethyldithiocarbamate inhibited the activity of both polyphenolase and peroxidase. On the other hand, 1-phenyl-2-thiourea inhibited peroxidase

less effectively than it did polyphenolase. Phloroglucinol, in the concentration range used, inhibited peroxidase more effectively than it did polyphenolase.

The effectiveness of L-ascorbic and D-isoascorbic acids as antioxidants for frozen peaches is presented.

8

ESTIMATION OF THE CHLOROPHYLL CONTENT AND MATURITY OF ELBERTA PEACHES BY USE OF LIGHT-TRANSMITTANCE TECHNIQUES

ARTHUR P. SIDWELL, GERALD S. BIRTH, JANE V. ERNEST, and CALVIN GOLUMBIC
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Rapid scanning spectrophotometric equipment especially designed for measurements of intact agricultural commodities was used for study of the light transmittance properties of maturing Elberta peaches. The most significant maturation-induced change in curves drawn over the range 500 to 900 mmc was a sharp decline in absorption in the region 650 to 700 mmc. This was accompanied by a less spectacular change in absorption in the region from 500 to 600 mmc.

The marked decline in light absorption of the intact fruit in the region from 650 to 700 mmc centered about the known chlorophyll absorption band at 675 mmc. Attempts were made to correlate the measurement of this decline with the extracted chlorophyll content of a series of peach samples harvested at intervals up to maturity. The relationship between light absorption at a wavelength within the apparently chlorophyll-sensitive area and that at one outside this area was calculated in order to diminish extraneous effects, such as fruit size. The chosen chlorophyll-sensitive wavelength was 700 mmc, since the measurement at 675 mmc did not encompass certain very immature lots. The chosen wavelengths outside this area ranged from 720 to 750 mmc.

This light transmittance relationship was calculated as difference in optical density (Δ OD). The correlations between extracted chlorophyll content and Δ OD were highly significant. The highest correlation was between Δ OD 740–700 mmc and the logarithm of the chlorophyll content in mcg per gram of fresh weight ($r = -0.96$). Measurements of the same peach samples, with the exception of the most immature lots, were also made on a newly designed dual monochromator spectrophotometer at wavelengths 695 and 725 mmc. The correlation coefficient between these measurements and logarithm of chlorophyll content was −0.94.

The average chlorophyll content of the peach samples declined with succeeding harvests and reached a very low level with advanced maturity. A significant relationship between taste panel ratings and light transmittance changes was also demonstrated.

It was concluded that light transmittance measurements offer promise in estimating the chlorophyll content and stage of maturation of Elberta peaches.

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BROWNING OF SUGAR SOLUTIONS. VI. ISOLATION AND CHARACTERIZATION OF THE BROWN PIGMENTS IN MAPLE SIRUP

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The brown color of maple sirup is developed during the concentration of the maple sap. Since there is no physical means of measuring maple flavor, maple sirup is graded on this color—the lighter the color the higher the grade. To set up processing procedures which will control the color in maple sirup, the mechanism of its development is being studied. As part of this work the colorant itself has been isolated and characterized. The color bodies—only a few parts per million in amount—have been separated from the other constituents of the sirup by ion exchange, concentrated and purified by dialysis, and characterized by chemical reactions and physical measurements. The knowledge gained about this particular colorant should be valuable to others concerned with the browning of foods.

10

THE CORRELATION OF COLOR MEASUREMENTS ON CANNED PURPLE PLUMS WITH CONSUMER ACCEPTABILITY

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In this phase of the investigation, color measures are taken as the closest approach to flavor or over-all quality designation. The correlation of 18 objective color dimensions and ratios with acceptability by panels averaging 145 student-consumers, using the customary hedonic scale was studied from the viewpoint of operational usefulness. For the higher correlations, 11 of which were significant at the 5% level, standard errors of estimation and predicting equations are given. The best measures for the Photovolt Reflectionmeter and the Hunter Color Meter showed correlation coefficients of A/G, 0.93 and a/Rd, 0.92, respectively. Per cent transmission of diluted syrup yielded a coefficient of 0.88. This is the first published report specifying in physical terms the color of this product as sampled from the open market and as related to consumer acceptability.

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COMPOUNDS RESPONSIBLE FOR THE COLOR OF BLACK "RIPE" OLIVES

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The production of uniformly dark black "ripe" olives has remained an empirical process due to lack of information concerning the compounds responsible for the color. Several polyphenols were separated by use of a silicic acid column and their reaction to air and KOH was noted. One compound having an R_f .68 in butanol-acetic acid-water appeared to darken most readily. This compound was purified by use of magnasal columns and counter current distribution. Infrared data shows strong peaks for hydroxy, CH_3 or CH_2, carbonyl and phenyl groups.

Evidence indicates that the compound is a bioside of glucose and another sugar probably xylose. The glycose hydrolyzes quite easily to form a monoside which polymerizes to a dark substance on further hydrolysis. Alkaline fusion yields protocatechuric acid plus another acid. The data suggest that the glycoside is of the flavonoid type of compounds, possibly a flavanone.

12

DIFFUSION STUDIES ON OLIGOSACCHARIDES

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The diffusion coefficients of the lower oligosaccharides found in hydrolysed starch (corn syrup) were measured in an ideal system. The effect of the presence of other sugars upon the diffusion coefficients was measured by a technique using C^{14} labelled sugars and measuring the diffusion of the active sugar in the presence of various concentrations of other inactive sugars.

The diffusion apparatus used and the technique of measurement are described. Results are presented and their significance in the penetration of the constituent sugars of corn syrup into the flesh of canned fruit is discussed.

13

SOME ASPECTS OF THE USE OF SUGARS IN FOOD PROCESSING

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Results of the research program of Sugar Research Foundation are reviewed. The program has been carried out at the University of California, University of Chicago, University of London, New York Agricultural Experiment Station, University of Nebraska, University of Wisconsin, University of Georgia, California Food Research Institute, Food Chemical and Food Research Laboratory, Oregon State College, The Massachusetts Institute of Technology, Arthur D. Little, Inc., Herstein Laboratories, Inc. and Bohn Food Research, Inc.

The four general principles that have emerged seem widely applicable to food research: (1) People like foods sweeter than tests with expert taste panels may indicate. (2) Sugars have an enhancing effect upon aromas which is related to the sugaring-out effect discovered in 1925 by Glasstone and Pound. (3) Sugars diminish the harshness of the other three tastes. (4) A broad flavor spectrum, properly balanced, is usually preferable to a narrower one.

14

SPECTROPHOTOMETRIC STUDIES OF THE PIGMENTS OF COOKED AND COOKED-CURED MEATS

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The insolubility and non-translucence of cooked meats makes spectrophotometric studies of their hemochrome and hemichrome pigments difficult. Reflectance spectra are useful but a major limitation is the diffuseness of the absorbance bands.

Techniques which have been developed for spectrophotometric studies of cytochromes in turbid suspensions and in tissues appear especially applicable to meat pigments. The use of difference spectra and low temperature will be described and illustrated.

Difference spectra of denatured globin hemochrome of meat minus the coresponding hemichrome are very analogous to difference spectra available on various cytochromes. Low temperature (−190° C) spectra of cooked cured meat allow good resolution of α and β bands which are difficult to differentiate at room temperature. The unusual 480 mmc band of cooked cured meats is likewise better resolved in difference and low temperature spectra than in reflectance spectra.

15

TRYPTOPHAN AND HYDROXYPROLINE AS THE INDEXES OF MUSCLE PLASMA PROTEINS AND THE CONNECTIVE TISSUE IN ANIMAL TISSUES AND THEIR USE FOR THE ESTIMATION OF NUTRITIONAL VALUES OF MEAT AND MEAT PRODUCTS

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Animal tissues consist of muscle plasma proteins (M) (myosin + actin ⇌ actomyosin, myogen, globulin-X, myoalbumin, myoglobin, enzymes) and/or connective tissue proteins (C) (collagen (Col) + elastin (E). These two groups of the proteins differ by their amino acids compositions, the main differences existing in the contents of tryptophan (T) (not present in C) and hydroxyproline (H) (not present in M). The amount of T in C-free M was found to be 1.45%, thus resulting the conversion factor of T into M of 69.0. The amount of H in C depends on the relative contribution of Col and E, which contain 14.0 and 1.8% H, respectively.

Based on these biochemical characteristics of the proteins of animal tissues a method has been developed for the estimation of the origin and nutritional value of various mixtures of the tissues, which involves the following steps:

1. Alkaline hydrolysis of animal tissue.
2. Determination of total protein in the hydrolyzed sample (P).
3. Determination of T in the sample [*J. Biol. Chem.*, 168. 711 (1947)].
4. Calculation of M in the sample (T × 69.0).
5. Calculation of C in the sample: P − (T × 69.0) = C.
6. Determination of the H concentration in the P(Hp). [*J. Agr. Food Chem.*, 2, 878 (1954)].
7. Calculation of H concentration in the C(Hc). Hp × (100/% C in the P) = Hc.
8. Per cent Col and E in the C: 14.0 × Col + 1.8 × (100 − Col) = 100 × Hc.

Since amino acid compositions of M, Col, and E are well known it is possible to calculate the amino acid composition in the mixture of animal tissue, when the amounts of M, Col, and E are determined in the mixtures. A mixture of animal tissue, consisting of lean meat and fatty tissue (rich in C) was hydrolyzed, the hydrolyzate analyzed for T and H, the amounts of M, Col, and E calculated, and the amino acid composition in the P of the mixture estimated. The same mixture of the tissue was analyzed for the 10 essential amino acids by using microbiological assay. The empirical and the estimated data for these 10 amino acids in the P of the mixture were in a very close agreement.

The method and its application for the estimation of the nutritional value of various animal tissues will be discussed.

16

COMPARISON OF RATE OF COOKING AND DONENESS OF FRESH AND FROZEN DEFROSTED TURKEY HENS

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Data for rate of heat penetration and doneness scores for fresh turkey hens were compared with those for frozen defrosted turkeys. During roasting, internal temperatures of fresh turkeys increased more rapidly than those of frozen turkeys. However, fresh and frozen turkeys were similar in doneness when roasted to 95° C in the thigh. Cooking times in minutes per pound and cooking losses were greater for frozen than fresh turkeys; whereas, flavor, juiciness, and tenderness scores were similar for all birds. Histological differences between fresh and frozen turkey samples also were investigated.

In addition, turkeys roasted with the breast up were compared with those roasted with the breast down. Internal temperatures of turkeys roasted with the breast up increased more rapidly than those roasted with the breast down. Cooking losses and cooking times were less for turkeys roasted with the breast up than for those roasted with the breast down. Doneness scores were similar for all birds.

17

THE EFFECT OF OVEN AIR TEMPERATURE, AIR FLOW AND PRESSURE ON THE ROASTING OF ROUNDS OF BEEF (YIELD AND ROASTING TIME)

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To determine the effect of oven air temperature, air flow and pressure on the yield (weight and volume) and roasting time of rounds of beef an experimental TVP oven (temperature, velocity, pressure) was designed and constructed to measure and control these variables up to 500° F, 80 scfm and 60 psig, respectively. A control oven was selected typical of the type commonly used in commercial roasting in which only temperature can be varied.

Choice grade 20-lb beef rounds were used as the test product, half of the round was roasted in the TVP oven under selected variable conditions and the other half in the control oven at 300° F for the first 30 tests as determined by common practice and at 250° F for the last 10 tests as determined by experimentation. The rounds were roasted to an internal temperature of 150° F as measured by the lowest of 9 thermocouple temperature points placed in a selected manner within the meat. Main effects, interactions and optimum conditions of the 3 variables were determined by designed sequential experimentation, analyzing the differences in yield and roasting time between the round roasted in the TVP oven and control oven.

Yield and roasting time were found to be generally correlated; as yield increases, roasting time increases. By using an experimentally determined combination of air temperature, air flow and pressure it was found that this correlation could be changed (reversed) and that within limitations yield could be increased and roasting time decreased. Air temperature and flow both had a significant effect on yield and roasting time. Pressure (saturated steam and/or air) had little effect on yield and roasting time. Weight and volume yield were found to be correlated. A temperature, flow, pressure interaction was noted.

18

MOISTURE CONTENT OF PORK MEAT AND ITS RELATIONSHIP TO LEANNESS

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Moisture content of pure red lean pork muscle tissue, and of pure white pork adipose tissue was studied. The results showed a limited variability of moisture content of muscle or adipose tissue. A relationship was established between meat moisture content and leanness. This relationship is expressed by the equation:

$L = 1.5M - 12.5$

Where L—is leanness in per cent
And M—is moisture content in per cent.

19

A COMPARISON OF THE INHIBITORY EFFECTS OF SORBATE, BENZOATE AND VITAMIN K_5 ON SELECTED YEAST STRAINS

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The effect of varying concentrations of sodium benzoate, sodium sorbate and vitamin K_5 on the growth of 5 selected yeasts at varying pH values has been studied. The medium used was composed of apple juice concentrate, sucrose, dipotassium phosphate, ammonium chloride and distilled water. Growth of the yeast was estimated by measuring, by refractometer, the depletion of the sugar in the medium. Results indicate that sodium sorbate is more effective as an inhibitor of yeast growth than is sodium benzoate. Lowering the pH of the medium en-

hances the effect of both. Vitamin K_5, in the concentrations employed, showed no inhibitory effect on yeast growth.

20
BENZOATE-RESISTANT YEASTS

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From three separate outbreaks of fermentation, in commercial citrus squashes preserved with 500 ppm benzoic acid, were isolated yeasts resembling a type strain of *Succh. acidifaciens*. The 3 strains differed in minor respects; but all of them, and the type strain (though more slowly), were shown to grow in presence of 500 mg/l of benzoic acid at pH 3.5, in synthetic media especially with 300 g/l of sugar.

The yeasts were virtually incapable of respiring or assimilating benzoic acid alone, but could apparently do so in presence of sugars.

As a result of their growth, the concentration of benzoic acid fell from 500 to 350–400 mg/l, and the following could be demonstrated:

(i) Substances chromatographically similar to A) *p*-hydroxybenzoic acid B) protocatechuic acid, C) catechol were produced.
(ii) From A, B and C were produced; from B, A and C; and from C, B and A.
(iii) With benzoic acid a strong absorption developed, at 230 mmc, the wavelength corresponding to L-γ-carboxymethyl-Δ^{α}-butenolide, a possible intermediate; and
(iv) A Rothera reaction developed, the substance responsible behaving chromatographically like β-ketoadipic acid.

There is thus presumptive evidence for the reaction sequence:

Benzoic = *p*-hydroxybenzoic = protocatechuic acid = catechol ⟶ L-γ-carboxymethyl-Δ^{α}-butenolide ⟶ β ketoadipic acid ⟶

21
GERMICIDAL EFFECT OF ORANGE PEEL OIL AND D-LIMONENE IN WATER AND ORANGE JUICE. PART I. FUNGICIDAL PROPERTIES AGAINST YEAST

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Orlando, Florida

Fungicidal effect of orange peel oil and D-limonene (stripper oil) was determined against *Zygosaccharamyces major* in water and in single strength orange juice at 25° C. Both oils exhibited lethal properties in water (pH 7.0) in concentrations as low as 0.02%, while in orange juice 0.1% was required. D-Limonene was more effective than orange peel oil in both water and orange juice.

The fungicidal properties of these oils in orange juice adjusted to various pH levels were determined. It was found that citrus peel oil and D-limonene were more effective at pH 6.0 and 7.0 than they were at pH 3.0 and 3.5. In one test orange juice adjusted to pH 7.0 with NaOH and containing 0.1% D-limonene was sterile 3 hours after being inoculated with 1,000,000 yeast cells per ml. In juice adjusted to pH 3.0 with citric acid, there were 100,000 viable cells per ml remaining at the end of a like period.

22
THE SANITATION ASPECTS OF FOOD PLANT CONSTRUCTION AND EQUIPMENT DESIGN AND INSTALLATION

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To reduce to an absolute minimum the amount of soil created by plant operations and to promote the efficiency and economy of the cleaning program, consideration must be given during the planning and design stages to the nature of the cleaning methods required by the nature of the soil created in the plant or equipment during its future operation.

Roughly dividing food processing industries into wet or dry operations, explicit recommendations are made concerning structural design, surface finishes, illumination and ventilation problems, structural insect and rodent control measures, waste disposal measures, materials handling systems, water, steam, air, and electrical distribution systems, etc. The principle of accessibility for cleaning of all direct and indirect food contact surfaces is presented and concrete examples are presented from a variety of industries.

Consideration of the principles discussed in this paper will result in substantially reduced cost of operation, better pest and extraneous filth control, more efficient quality control, and reduced spoilage.

23
MICROBIOLOGICAL STANDARDS FOR FOODS

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Low Temperature Research Station
Cambridge, England

Microbiological standards are expensive to operate and full of difficulties. They must be chosen to suit their particular purpose: to indicate perishability, general hygienic state, or pathogenic hazard. Especially with the latter, the indication may not be direct. The standard is a number which—however seldom—rests on a firm numerical basis and is often more or less arbitrary, depending on a loose correlation with some other property. For comparison with the standard, the number or activity of microorganisms in the food has to be determined. But satisfactory sampling may be impossible, between containers or within a container. Usually, the samples cannot be stored. Enumeration of the organisms may be ambiguous: it is always subject to statistical uncertainty. Such standards are fundamentally unsuitable for promulgation where they are likely to be subject to legal argument.

24
PEST CONTROL — EX POST FACTO?

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By applying corrective rather than preventive pest control measures, many food processing firms are subjecting themselves to unnecessary risk of product adulteration and embarrassing legal action. In many cases this practice is also much more expensive. *Enforced* standards of quality for raw materials and ingredients, suitable warehousing and processing structures, correct storage practices and conditions, and appropriate chemical and mechanical control measures are the essence of *preventive* pest control.

A number of examples are presented by way of demonstration in each of the three major catagories.

Certain micro-flora, in addition to insects and rodents are considered as "pests" for the purpose of this paper.

Responsibility for pest control cannot be "farmed out". Industry has available to it a variety of economical and effective methods to protect itself from these hazards, but is not now always using them to best advantage.

25
COMMERCIAL DEVELOPMENT OF AN AEROSOL WHIPPED TOPPING

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Until very recently, only one type of food product in an aerosol container had reached an appreciable level of distribution. This one product is whipped cream, and its counterpart based on vegetable fat. Experiences gained in this field can serve a very useful purpose in highlighting certain major considerations which will probably be encountered in the development of other food products for aerosol packaging.

Among factors which call for special attention are the following:

1. Product reformulation to a major extent is often required in the interest of developing physical characteristics which lend themselves to aerosol dispensing.
2. Processing, storage, distribution, and shelf-life characteristics of an aerosol packaged product will probably differ to a considerable extent from those encountered with a similar product in conventional packaging.
3. Customer reaction to basic changes in product identity, which may necessarily occur as a result of formulation to meet the packaging requirements, must be carefully evaluated.
4. Aerosol packaging adds considerably to the cost of most food products, when compared with the same items in conventional packages. The added convenience provided by such packaging must be carefully appraised in each instance, in relation to the customer's willingness to pay the additional cost.

These factors, along with certain others, will be discussed in the light of experience gained in the commercialization of a vegetable fat base aerosol topping.

26
THE ROLE OF CONVENIENCE IN FOOD SELECTION

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and T. M. BROOKS
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Technical advances have resulted in decreased labor inputs per unit of output and have created a feeling that labor saving for its own sake is desirable. Thus, many homemakers are interested in convenience items and services without necessarily having in mind alternative uses for the time saved. Interest in conveniences does not have to be justified on the basis of choice in use of time or on effort expended.

Convenience takes many forms. Ease of opening, handling or storing may be decisive factors in selection. In Harrisburg, Pennsylvania, homemakers selected boxed cereal over a cellophane package at a 7 to 1 ratio. About 20% justified the selection of the more expensive package on product factors. The remainder justified their selection on a convenience basis. Selection of a particular brand of an economy item like dry milk solids was justified on a convenience basis.

Convenience emphasis varies with the homemaker's belief in her ability to select foods. Packaged potatoes and loose apples were preferred by about two-thirds of the interviewees.

Another problem is how to introduce convenience foods without removing the satisfaction and status that the homemakers receive from creativity in meal preparation and serving. Given time, however, the conflict between status and convenience appears to be resolved in favor of convenience. For instance, the study of Harrisburg homemakers showed that 96% of those who would serve angel cake to their families would be willing to serve a cake made from a commercial mix.

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Western Utilization Research and Development Division
U. S. Department of Agriculture, 800 Buchanan Street
Albany 10, California

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THE VITAMIN FORTIFICATION OF POTATO FLAKES

JAMES CORDING, JR.,* RODERICK K. ESKEW,*
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Philadelphia 18, Pennsylvania
** Hoffmann-La Roche Inc., Nutley 10, New Jersey

In view of the increased use of mashed potatoes since the advent of such convenience foods as potato flakes, the study of restoration and fortification of flakes with vitamins was considered important. Studies were made to determine the retention of natural and added vitamins in the dehydration process and of their retention on storage at different temperatures in air and nitrogen.

Data are given on the stability of added vitamins A, B_1, B_2 and niacin and of natural and added vitamin C. The fortification of potato flakes with vitamins A and C would appear to be practical. Fortification with vitamin B_1 is not practical because of the high processing losses due to the presence of sulfite in the potato mash. Fortification with riboflavin imparts an undesirable yellow color to the reconstituted flakes.

The potato as a regularly consumed low cost food, when fortified, would provide a good means of adding these nutrients to our diets. This is important since nutrition surveys made during the past several years have indicated that vitamins A and C are still present at unsatisfactory levels in our dietary.

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DEVELOPMENT OF PRE-COOKED, DEHYDRATED MEAT ITEMS FOR MILITARY USE

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Quartermaster Food and Container Institute for the Armed Forces
1819 West Pershing Road
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One of the important physical characteristics of the so-called "quick-serve" foods for the Armed Forces is the texture or bite. To gain wide acceptance a product must reconstitute in hot water to a texture very close to that of the "just prepared" product. This goal is particularly difficult to attain with fried foods preserved by conventional means since the more or less crisp crust which is characteristic of these foods is rapidly lost if moisture is available for the crust to absorb. Once the initial crispness is lost, it is practically impossible to restore it without the application of dry heat. Since freeze dehydrated products are preserved at very low moisture levels, it is possible to design dehydrated fried products which, if protected against moisture and oxygen, will (1) remain stable indefinitely and, (2) when properly rehydrated with hot water will quickly develop a texture simulating that of a freshly fried product. One prototype item under development at the QMF&CI which fulfills this objective for rehydrated texture as well as speed of rehydration is fish patties. Formulated from cooked fish and either corn meal or potatoes and then fried and dehydrated, the patties rehydrate in about 15 seconds with a resulting texture practically indistinguishable from the fresh fried product. The crust is very porous so that it does not prevent water penetration to the interior of the pattie; however, it is sufficiently resistant to wetting to delay softening when immersed for a period substantially longer than required for full rehydration of the interior. On standing, the crust will lose crispness, but at about the same rate as the crust of a freshly prepared pattie.

30

SOME PRACTICAL FACTORS TO CONSIDER IN USING INSTANT NONFAT DRY MILK IN QUANTITY FOOD PREPARATION

MADGE LITTLE
American Dry Milk Institute, Inc., 221 North La Salle Street
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Objectives were (1) to study the performance of instant nonfat dry milk in preparation of foods having wide usage in daily menus and (2) to develop formulas and procedures that would encourage institutional operators to use instant nonfat dry milk.

All sources of ingredients, except instant nonfat dry milk, were kept constant for comparison of product quality. The instant nonfat dry milk used was obtained from three processors. Curd tension, absorption and stability tests were run on all samples preliminary to formula testing.

Scores on all items prepared were recorded by a panel of laboratory technicians and food service operators. Recommendations for improvement of quality of foods prepared and simplification of procedures were based on above findings.

The regular low heat spray process and the instant brands used in the same amounts by weight in preparation of selected products, showed no discernible differences in final food quality. Results indicated that the commercial brands could be used interchangeably by weight in fluid or dry state. Some proportions and temperatures were adjusted which helped clear some problems experienced in specific cooking and counter holding.

31

THE EFFECT OF PREPARATION ON THE STABILITY AND PERFORMANCE OF FROZEN, UNBAKED YEAST-LEAVENED DOUGHS

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The merchandising of unbaked bread and rolls to the consumer through retail markets requires a knowledge of the effect of various factors that influence the characteristics and quality of the product. A study was made of the effect of the quantities and kinds of materials used in the formulation. Procedures in which the fermentation was varied prior to freezing the doughs were varied. Types of yeast used in the fermentation were compared. Doughs were held for prolonged storage periods and the stability studied. Effects of alternate thawing and re-

hances the effect of both. Vitamin K_4, in the concentrations employed, showed no inhibitory effect on yeast growth.

20
BENZOATE-RESISTANT YEASTS

M. INGRAM
Low Temperature Research Station
Cambridge, England

From three separate outbreaks of fermentation, in commercial citrus squashes preserved with 500 ppm benzoic acid, were isolated yeasts resembling a type strain of *Sacch. acidifaciens*. The 3 strains differed in minor respects; but all of them, and the type strain (though more slowly), were shown to grow in presence of 500 mg/l of benzoic acid at pH 3.5, in synthetic media especially with 300 g/l of sugar.

The yeasts were virtually incapable of respiring or assimilating benzoic acid alone, but could apparently do so in presence of sugars.

As a result of their growth, the concentration of benzoic acid fell from 500 to 350–400 mg/l, and the following could be demonstrated:

(i) Substances chromatographically similar to A) *p*-hydroxybenzoic acid B) protocatechuic acid, C) catechol were produced.
(ii) From A, B and C were produced; from B, A and C; and from C, B and A.
(iii) With benzoic acid a strong absorption developed, at 230 mmc, the wavelength corresponding to L-γ-carboxymethyl-Δ^{α}-butenolide, a possible intermediate; and
(iv) A Rothera reaction developed, the substance responsible behaving chromatographically like β-ketoadipic acid.

There is thus presumptive evidence for the reaction sequence:

Benzoic = *p*-hydroxybenzoic = protocatechuic acid = catechol ⟶ L-γ-carboxymethyl-Δ^{α}-butenolide ⟶ β ketoadipic acid ⟶

21
GERMICIDAL EFFECT OF ORANGE PEEL OIL AND D-LIMONENE IN WATER AND ORANGE JUICE. PART I. FUNGICIDAL PROPERTIES AGAINST YEAST

D. I. MURDOCK and W. E. ALLEN
Minute Maid Corporation
Orlando, Florida

Fungicidal effect of orange peel oil and D-limonene (stripper oil) was determined against *Zygosaccharamyces major* in water and in single strength orange juice at 25° C. Both oils exhibited lethal properties in water (pH 7.0) in concentrations as low as 0.02%, while in orange juice 0.1% was required. D-Limonene was more effective than orange peel oil in both water and orange juice.

The fungicidal properties of these oils in orange juice adjusted to various pH levels were determined. It was found that citrus peel oil and D-limonene were more effective at pH 6.0 and 7.0 than they were at pH 3.0 and 3.5. In one test orange juice adjusted to pH 7.0 with NaOH and containing 0.1% D-limonene was sterile 3 hours after being inoculated with 1,000,000 yeast cells per ml. In juice adjusted to pH 3.0 with citric acid, there were 100,000 viable cells per ml remaining at the end of a like period.

22
THE SANITATION ASPECTS OF FOOD PLANT CONSTRUCTION AND EQUIPMENT DESIGN AND INSTALLATION

BENJAMIN BUCHALTER
Industrial Sanitation Service, P. O. Box 851
Belmont, California

To reduce to an absolute minimum the amount of soil created by plant operations and to promote the efficiency and economy of the cleaning program, consideration must be given during the planning and design stages to the nature of the cleaning methods required by the nature of the soil created in the plant or equipment during its future operation.

Roughly dividing food processing industries into wet or dry operations, explicit recommendations are made concerning structural design, surface finishes, illumination and ventilation problems, structural insect and rodent control measures, waste disposal measures, materials handling systems, water, steam, air, and electrical distribution systems, etc. The principle of accessibility for cleaning of all direct and indirect food contact surfaces is presented and concrete examples are presented from a variety of industries.

Consideration of the principles discussed in this paper will result in substantially reduced cost of operation, better pest and extraneous filth control, more efficient quality control, and reduced spoilage.

23
MICROBIOLOGICAL STANDARDS FOR FOODS

M. INGRAM
Low Temperature Research Station
Cambridge, England

Microbiological standards are expensive to operate and full of difficulties. They must be chosen to suit their particular purpose: to indicate perishability, general hygienic state, or pathogenic hazard. Especially with the latter, the indication may not be direct. The standard is a number which—however seldom—rests on a firm numerical basis and is often more or less arbitrary, depending on a loose correlation with some other property. For comparison with the standard, the number or activity of microorganisms in the food has to be determined. But satisfactory sampling may be impossible, between containers or within a container. Usually, the samples cannot be stored. Enumeration of the organisms may be ambiguous: it is always subject to statistical uncertainty. Such standards are fundamentally unsuitable for promulgation where they are likely to be subject to legal argument.

24
PEST CONTROL — EX POST FACTO?

BENJAMIN BUCHALTER
Industrial Sanitation Service, P. O. Box 851
Belmont, California

By applying corrective rather than preventive pest control measures, many food processing firms are subjecting themselves to unnecessary risk of product adulteration and embarrassing legal action. In many cases this practice is also much more expensive. *Enforced* standards of quality for raw materials and ingredients, suitable warehousing and processing structures, correct storage practices and conditions, and appropriate chemical and mechanical control measures are the essence of *preventive* pest control.

A number of examples are presented by way of demonstration in each of the three major catagories.

Certain micro-flora, in addition to insects and rodents are considered as "pests" for the purpose of this paper.

Responsibility for pest control cannot be "farmed out". Industry has available to it a variety of economical and effective methods to protect itself from these hazards, but is not now always using them to best advantage.

25
COMMERCIAL DEVELOPMENT OF AN AEROSOL WHIPPED TOPPING

HEBER R. BALDWIN
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Glenview, Illinois

Until very recently, only one type of food product in an aerosol container had reached an appreciable level of distribution. This one product is whipped cream, and its counterpart based on vegetable fat. Experiences gained in this field can serve a very useful purpose in highlighting certain major considerations which will probably be encountered in the development of other food products for aerosol packaging.

Among factors which call for special attention are the following:

1. Product reformulation to a major extent is often required in the interest of developing physical characteristics which lend themselves to aerosol dispensing.
2. Processing, storage, distribution, and shelf-life characteristics of an aerosol packaged product will probably differ to a considerable extent from those encountered with a similar product in conventional packaging.
3. Customer reaction to basic changes in product identity, which may necessarily occur as a result of formulation to meet the packaging requirements, must be carefully evaluated.
4. Aerosol packaging adds considerably to the cost of most food products, when compared with the same items in conventional packages. The added convenience provided by such packaging must be carefully appraised in each instance, in relation to the customer's willingness to pay the additional cost.

These factors, along with certain others, will be discussed in the light of experience gained in the commercialization of a vegetable fat base aerosol topping.

26
THE ROLE OF CONVENIENCE IN FOOD SELECTION

M. E. JOHN, R. L. BAKER, H. B. BYLUND,
and T. M. BROOKS
The Pennsylvania State University
Department of Agricultural Economics
University Park, Pennsylvania

Technical advances have resulted in decreased labor inputs per unit of output and have created a feeling that labor saving for its own sake is desirable. Thus, many homemakers are interested in convenience items and services without necessarily having in mind alternative uses for the time saved. Interest in conveniences does not have to be justified on the basis of choice in use of time or on effort expended.

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freezing were observed. It was found that doughs made with active dry yeast, unfermented prior to freezing, had excellent stability over a long period of time and if properly formulated, yielded baked products of acceptable quality.

32
INSTANT BREAD MIX: CONSUMER ACCEPTANCE OF PREPARED BREAD

MARION SIMONE, NANCY SHARRAH, and C. O. CHICHESTER
Department of Food Science and Technology
University of California
Davis, California

A consumer panel of 100 households evaluated the eating quality characteristics of instant bread made with flavors prepared by four different procedures. The single stimulus method of sample presentation was used. Consumers assigned an average rating of 4.65 to the breads, indicating an acceptability level of like slightly to like moderately on the 7-point hedonic scale used. Very highly significant differences in acceptability due to age and sex variations among the consumers were noted. Rating differences among the 4 flavoring preparations were small.

33
INSTANT BREAD MIX: STUDIES ON THE DEHYDRATION OF FLAVORING MATERIALS

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Department of Food Science and Technology
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Davis, California

Three different drying methods for the production of the flavoring ingredients for instant bread were investigated. The conditions of preparation of the bread flavoring ferment were varied to facilitate the various drying methods. The relation between additive agents and drying characteristics were determined.

A procedure for the production of dried flavoring mix by drum, freeze, and spray drying was developed. Sensory evaluation of the products of the drying procedures were conducted.

34
GRANULATED POTATO FLAKES

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Pursuant to current work at the Eastern Utilization Research and Development Division on reducing the bulk of potato flakes to better adapt them to institutional and military use, a method has been found for surpassing the 32 lb per cubic foot value, representing the approximate limit that may be had by grinding flakes.

The new procedure consists simply in rehydrating potato flakes to a moisture content of between about 38–45% and mixing as currently done with granules, thereafter drying as granules are dried, i.e., in air lift and/or fluidized bed driers. The unique feature is that when flakes are made by the process developed at the Eastern Utilization Research and Development Division they are granulated completely when agitated to equilibrate moisture in the range mentioned above. The precooking and cooling steps in the standard flake process coupled with the use of proper amounts of monoglycerides assures the absence of stickiness that would otherwise arise from unretrograded amylose.

The advantages are that repeated recycling of dried product is eliminated, quality control is facilitated and mixing and air lift drying capacity can be greatly reduced below that required in the conventional granule process.

35
PRECIPITATION OF FOOD GUMS BY THIAZINE, OXAZINE AZINE AND OTHER BASIC DYES: SPECIFICITY OF THE METHYLENE BLUE—CARRAGEENAN REACTION

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For years, a specificity akin to the antigen-antibody reaction has been ascribed to the interaction between methylene blue, a thiazine dye, and carrageenan, a sulfated polysaccharide, used widely as a stabilizer in many food products. Experiments were designed to test the validity of this theory.

Several thiazine, azo, azine, oxazine and other basic dyes were reacted with dialyzed and undialyzed samples of commercial carrageenan, highly purified samples of kappa and lambda fractions of carrageenan, furcellaran, fucoidan, agar, polyglucose sulfate, polygalacturonic acid and many other commercially important food gums. The nature of the precipitates formed was observed visually, taking the methylene blue-carrageenan precipitate as the standard.

Of the gums tested only furcellaran, with methylene blue, gave a stringy precipitate indistinguishable from that given by carrageenan. Of the dyes used, the thiazines such as methylene blue and toluidine blue O, the azo dyes such as janus green B and bismarck brown, with carrageenan, its fractions and furcellaran, gave stringy precipitates indistinguishable from that given by methylene blue. Neutral red, an amidoazine dye, also gave the characteristic stringy precipitate.

The results indicate that the methylene blue-carrageenan reaction is much less specific than heretofore reported.

In order to obtain a methylene blue-carrageenan-like precipitate the following conditions are apparently necessary: (1) the chromophore structure of basic dyes of the azo, thiazine, oxazine, and azine types must be present, (2) the polygalactose and/or the 3,6 anhydro galactose structure must be present, (3) esterification equal to or probably close to that found in carrageenan and furcellaran must be present.

36
SPECTROPHOTOMETRIC AND CHROMATOGRAPHIC STUDIES OF HIBISCUS SABDARIFFA EXTRACTS

HUSSEIN O. A. OSMAN
University of Alexandria* (UAR) and Rutgers University*
New Brunswick, New Jersey

Bate-Smith (Nature, 161, 835, 1948) published some "straight R_f," values for anthocyanins and related compounds but did not recommend relying on R_f values of these compounds for identification. Seshadri *et al* (*Proc. Indian Acad. Sci.* 36A, 157–69, 1952) stated that "paper chromatography is dependable in surveying anthoxanthin." They used circular paper chromatography.

Extracts of *Hibiscus* Sabdariffa (Karkade or Roselle) grown in the Republic of the Sudan gave five "straight" R_f values. They also had absorption maxima at five different wave lengths 228.5, 285, 420, 545, 660 MM. Three of these values coincide with absorption maxima reported by Seshadri *et al;* namely, 228, 285, 544 mmc.

A discussion on the reliability of R_f values in identifying anthocyanins and related compounds is included.

* Work initiated at the Food Technology Dept., University of Alexandria, UAR, and continued when on sabbatical leave at the Food Science Dept., Rutgers University.

37
ESTIMATION OF ALCOHOL AND SUGAR CONTENTS OF ALCOHOLIC BEVERAGES BY REFRACTIVE INDEX, SPECIFIC GRAVITY, AND DILATOMETRIC METHODS

R. J. VILECE and A. S. LEVINE
University of Florida
Gainesville, Florida

Sucrose and ethanol increase the refractive index of an aqueous solution, and sucrose increases the specific gravity, but ethanol decreases the specific gravity. Although specific gravity or refractive index each define only a series of combinations of sucrose and ethanol in water, there is only one combination of these ingredients which will give a specified refractive index *and* specific gravity. Since the principal ingredients of alcoholic beverages are alcohol and water (and sugar in some), a quick estimation of these constituents can be made by means of a refractometer reading and a sensitive specific gravity spindle reading, using tables prepared from known solutions. Correction factors may be applied to products containing significant quantities of other solutes, providing they remain relatively constant from batch to batch.

Another characteristic which depends on the ethanol content of an aqueous solution is the increase in volume due to an increase in temperature. A table was prepared showing the increase in volume of water, ethanol, and solutions of them when the temperature was raised 70° C.

38
RAPID METHOD FOR REMOVING ORGANIC COATINGS FROM TIN CANS

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Chicago 9, Illinois

Tinned cans are coated with lacquer, enamel, or other material, to protect the underlying metal, to serve as military camouflage, or for lithographic purposes. This coating must be removed prior to determining the weight of tin plate. Commonly available organic solvents, popular formulas, recommended commercial coating removers, an abrasive technique, and an electromotive

method proved unsuitable for removing the coatings encountered. In each case, too long a time was required, or the tin plate was affected. However, the trials did indicate that a hot, aniline-ammonium hydroxide mixture would make an effective coating remover. Experiments showed that 1 part of aniline to 10 parts by volume of 12% ammonium hydroxide was a satisfactory coating remover. Coated specimens were immersed in this mixture at near-boiling temperature under a fume hood. Coatings rapidly floated free or could be flushed off with running water. Tin plate was not affected.

39

THE EFFECT OF METHOD OF CARE ON THE FRYING LIFE OF FAT

M. ELIZABETH RUST and DOROTHY L. HARRISON
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Manhattan, Kansas

The rate of deterioration of fat used for deep fat frying affects the raw food cost of a food service. The effect of 4 methods of care on the frying life and cost (grams fat per 100 g serving) of fat used for frying potatoes was investigated.

Methods of care were: I—filtered, stored in covered container at 2° to 5° C, and 20% (of original weight) fresh fat added each frying period; II—filtered, stored in cleaned fryer at 27° ± 3° C, and 20% fresh fat added each frying period; III—filtered, stored in cleaned fryer at 27° ± 3° C, and fresh fat added to replace that lost during frying; and IV—skimmed, stored in fryer at 27° ± 3° C, and fresh fat added to replace that lost during frying.

The frying life (determined by palatability scores for potatoes) of fat cared for by methods I and II was more than twice that of fat cared for by methods III and IV. However, when fat was cared for by methods I and II the quantity required per 100 g serving of potatoes was approximately twice that required by methods III and IV.

The method of care had no significant effect on acid number and viscosity of the fat, or on the fat content and weight loss of the potatoes. Regardless of method of care there was a highly significant negative correlation between the acid number of the fat and acceptability of the potaoes.

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SOME FACTORS AFFECTING THE INHIBITION OF THE CUPRIC OXIDATION OF ASCORBIC ACID BY CALCIUM EDTA (DISODIUM CALCIUM ETHYLENEDIAMINE TETRAACETATE)

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The sodium and calcium salts of ethylenediaminetetraacetic (EDTA) acid, because of their chelating properties, may modify any chemical reaction catalyzed by trace metals such as Cu, Fe, Ni or Co. One of the most important of these trace element reactions to the food technologist is the catalytic oxidation of ascorbic acid by cupric ions. Unfortunately, the literature contains conflicting statements concerning the effects of EDTA derivatives in modifying this ascorbic acid oxidation.

The object of this work was to study quantitatively some of the factors that might affect the inhibition of the cupric oxidation of ascorbic acid by calcium EDTA. The latter compound was chosen because of its suitability for food use as evidenced by the results of two year animal feeding studies.

Quantitative studies using the Warburg manometer technique show that the inhibition of ascorbic oxidation by CaEDTA is most marked at pH 3, less so at pH 4.0 and least at pH 7.0. The effect of glucose, citric acid, and various amino acids alone and in combination with CaEDTA was also studied at the various pH levels. Cysteine was one of the amino acids that inhibited the catalytic oxidation independently of the effect brought about by CaEDTA. The relation of these findings to the stability of ascorbic acid in various foods will be discussed.

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OXYGEN-SCAVENGERING PACKET FOR IN-PACKAGE DEOXYGENATION

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An oxygen-scavengering packet for in-packet oxygen removal has been developed. *OxyBan* is a dry-appearing, granular product containing glucose oxidase, catalase, buffers, and glucose on an inert non-toxic carrier. For commercial use the packets come in activated form; in the absence of oxygen they remain at peak activity for months. Nominally rated at 10 ml O_2/g in use, the uptake can be as high as 16 or more ml O_2/g under ideal conditions.

The effect of such variables as particle size and makeup, shape of container, initial oxygen level, and other factors on the rate and degree of oxygen removal will be discussed.

By completely removing oxygen, the use of *OxyBan* may permit the economical packaging of products not hitherto distributed commercially, and greatly extend the period of retention of original packed flavor in other food products, as well as possibly replacing, in some cases, vacuum packaging and nitrogen flushing.

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LONG-TERM STORAGE OF PROCESSED FOODS

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To aid in establishing a more realistic program for provisioning military and civilian populations, a research project on Long-Term Storage of Military Rations and Heat-Processed Non-military Items was conducted at the Georgia Experiment Station. Included were 8 bakery and cereal products, 15 confections, 7 dairy products, 15 meat and fish items, 6 fruits, 10 vegetables and 7 miscellaneous products. The storage conditions were: −20° F, −10°, 0°, 32°, 47°, 70° (with 50% and 90% rh), and 100° (with 50% and 90% rh). Examinations were made after 3, 6 or 12 months, depending upon the temperature used; and included sensory evaluations, physical and chemical changes in the product and conditions of the containers. A total of about 111,500 individual cans or packages of food were included in 3 separate experiments. The length of the various experiments was 2, 7 and 5 years. Results show that all of the 68 products responded favorably to refrigeration, though freezing and thawing degraded certain canned products in texture. Rates of decrease in quality varied among different foods and containers and were usually non-linear functions of time, often non-geometric functions of temperature and were apparently discontinuous in some commodities not damaged by storage below 0°. Reasonable predictions of storage life for certain foods may require previous data within the same range of storage conditions. Complete results from this study are being prepared for a series of 6 reports.

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NATURAL GUMS AND STABILIZERS FOR THE FOOD PROCESSOR

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Natural water-soluble gums play an important role in a wide variety of foods including beverage, confectionery, dairy, bakery, ice cream and processed meat products, where they are used as thickeners, emulsifiers, and stabilizers.

A short review of these essential foods materials is presented and their general properties and applications are discussed. Factors are considered so as to simplify the selection of the appropriate stabilizer or gum for a particular food item. The importance of quality control on the part of the food processor is emphasized with practical suggestions as to methods and instrumentation. This is the third in a series of papers presented on the use of carbohydrate thickeners in food and food processing.

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STUDIES ON ENGLISH (PERSIAN) WALNUTS, *JUGLANS REGIA*. II. STABILIZATION OF KERNELS

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Shelled walnuts are highly susceptible to skin darkening and the development of rancidity. Kernel moisture is a primary factor in causing deterioration at ambient and elevated temperatures. The stabilities of untreated and antioxidant-treated kernels have been compared under ambient conditions at moisture levels between 2.8–4.0%. Kernel stability was estimated by organoleptic evaluations, measurements of peroxide values, free fatty acids and oxygen absorption.

The development of peroxides, free fatty acids, and off-flavors, as well as the absorption of oxygen, increased generally with increased holding time. However, transient cyclic variations among these quality criteria have been observed consistently for antioxidant-treated and especially untreated kernels at low moisture levels. These cyclic variations appeared to be interrelated in a manner which suggests that oxygen absorption was associated with the formation of peroxides, development of free fatty acids and deterioration of organoleptic quality. Transient im-

provements in acceptability appeared to be associated with successive reductions in peroxide values, minimal rates of free fatty acid formation, and lowered oxygen absorption. The peaks and troughs observed for these variables as a function of time were detectable only within or slightly below the optimum moisture range where their rates of change were reduced significantly.

Antioxidant-treated kernels containing from 2.8–4.0% moisture remained acceptable for periods up to 18 months. Under the same conditions untreated kernels remained acceptable for only 4–6 months depending upon their moisture content. Optimum stability was demonstrated for both untreated and antioxidant-treated kernels at 3.0–3.5% moisture.

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COMPARATIVE ACTION OF PROTEASES ON PROTEINS

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The technique of sequential digestion of proteins by different enzymes is a powerful tool to simply and convincingly compare the specificity of different enzymes. At the same time this technique gives a comparison of the abundance of certain peptide linkages in different proteins and thus could serve to characterize new proteins.

Our studies showed that bromelain has an action more like that of ficin than that of papain. On fibrin the action of the two enzymes was the same. Papain, on the other hand, hydrolyzed some bonds not split by bromelain or ficin and did not hydrolyze others which were. Casein, elastin, and gelatin all contained certain linkages which ficin split but bromelain did not. Again papain had an action different from that of bromelain or ficin.

Neither crystalline trypsin nor chymotrypsin was exactly comparable in its action with the plant or fungal proteases. These results are in contrast to the work to date on the characterization of these enzymes by synthetic substrates.

Two commercial fungal proteases had a markedly different action on proteins. One caused no further digestion on protein digested by bromelain or ficin whereas the other caused a large increment of digestion with the bromelain digested sample.

These and additional studies with other enzymes and proteins should give the food technologist information which he can use to choose the enzyme or combination of enzymes which will do the most effective job.

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PROPERTIES OF THE ACID PHOSPHATASES IN COMMERCIAL PINEAPPLE STEM BROMELAIN

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Canadian workers have shown that phosphopeptones are responsible for the bitter flavor in soybean protein hydrolysates. It is therefore postulated that any enzyzme which would split serine phosphate might improve the flavor of casein, egg yolk, or soybean hydrolysates. Pineapple stem bromelain contains large amounts of two acid phosphatases. These were studied to determine how they should be handled to obtain maximum activity.

In commercial preparations the enzymes were only moderately stable, being destroyed by moderate temperatures (E = 15,000 calories/mole). However, in stabilized preparations the enzymes were resistant to temperatures above 65° C. Commercial bromelain contained two dissimilar colloids with acid phosphatase activity, one had an isoelectric point below pH 5.0 and the other above pH 8.0.

The pH of optimum activity on glycerolphosphate or p nitrophenylphosphate was pH 6.0. There were two apparent peaks of stability, one at pH 5.0 and one between pH 7.0–8.0. Of the cations tested only zinc and mercury were strongly inhibitory. Cobalt, nickel, and manganese inhibited certain preparations moderately. Of the anions tested only molybdate was strongly inhibitory. Fluoride, arsenate, and phosphate were moderate inhibitors. All of the sulfhydryl inhibitors activated the enzymes at certain concentrations. Hydrogen peroxide was a potent inhibitor.

The phosphatases were able to hydrolyze glycerolphosphate, dinitrophenylphosphate, nitrophenylphosphate and serine phosphate. No action was found on nucleic acids under the experimental conditions tested.

Many of the anomalous results found in the commercial preparation appear to be caused by micelle formation or aggregation of the oppositely charged colloids.

The pineapple stem is a rich source of acid phosphatases. However, to use them in food products they must either be stabilized by inhibiting an associated oxidase-peroxidase system or they must be purified.

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THE INHIBITION OF POLYGALACTURONASE IN BRINED CHERRIES

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Brined cherries are the raw products from which maraschino type cherries are made. The brine is made up of 1¼% sulfur dioxide, a preservative and bleaching agent, and ¾% calcium hydroxide. The calcium acts as a firming agent.

In contrast to ordinary processed foods the main consideration is the texture or firmness of the cherries, the color and flavor being added artificially during the maraschino manufacturing.

The firmness of the cherries relies primarily on the natural pectin present, when the pectin is destroyed the cherries become soft. This softening resulted in a loss of ¾ million dollars in one year for one locality alone.

The destruction of pectin has been found to be due to the action of the pectin degrading polygalacturonase. The source of this enzyme has not yet been determined, although microorganisms and/or plant diseases have been suspected.

While the search for the source of polygalacturonase continues, its possible inhibitors have been investigated. The enzyme apparently is not inhibited by either sulfur dioxide or calcium hydroxide, but experiments show that it may be inhibited, in the presence of cherry brine, by several alkyl aryl sulfonate detergents. Typical examples of these detergent inhibitors are commercially known as Nocconol, Oronite, and HD 90.

Sodium alkyl aryl sulfonate added to the cherry brine in the concentration of 0.01 to 0.10% completely inhibited polygalacturonase within 30 minutes. The efficiency of the commercial leaching process for the removal of the detergent was determined by radioisotope tracer techniques. It was found that 3% of the added alkyl aryl sulfonate remained in the leached cherries. The residual detergent shows no effect on the final product of maraschino cherry manufacture.

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DEVELOPMENTS IN THE ROLE OF ENZYMES IN THE SOFTENING OF BRINED CHERRIES

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Major losses from softening of cherries in brine have occasionally troubled the multimillion dollar cherry brining industry. Losses are due to mushing of sweet cherries when they are held in calcium bisulfite brines while awaiting remanufacture for use in canning or maraschinos. Varying amounts of pectinases may ocur in cherry brines. Their source remains uncertain. Experimental packs of brined cherries were made in Washington and in California during two seasons. Variables in the packs included initial pectinase content, added enzymes, enzyme inhibitors, variations in brine formulations, fruit variety and condition, and microorganisms either naturally occurring or added. From the several hundred experimental samples, plus observations in orchards and packing plants, no single factor has been isolated as being responsible. However, high to very high levels of assorted pectinases were generally associated with breakdown, while low to zero levels of pectinase were usually associated with firm cherries. The addition of sufficient alkyl aryl sulfonate has been effective in reducing softening in the presence of added pectinases. Also effective as an inhibitor of pectinase were Scuppernong grape leaves. Variations in the formulations of brines used by the industry were of relatively minor effect, although higher calcium levels tended to correlate with increased firmness. Experimental brining of several lots of very moldy cherries gave firm fruit after the curing period. From various lots of cherries plated-out on several media (esp. cherry juice) for colony selection, *Penicillium expansum* and *Pullularia pullulans* have shown considerable pectinase activity. Results of other variables are reported.

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ENZYMATIC CONVERSION OF BARLEY CARBOHYDRATES TO SYRUP

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A study has been made on the yield and kind of sugars produced from whole barley by the use of various commercial and laboratory prepared enzymes. The effects of temperature, enzyme concentration, conversion time and mash strength on the yield of sugars were determined. An appreciable reduction in conver-

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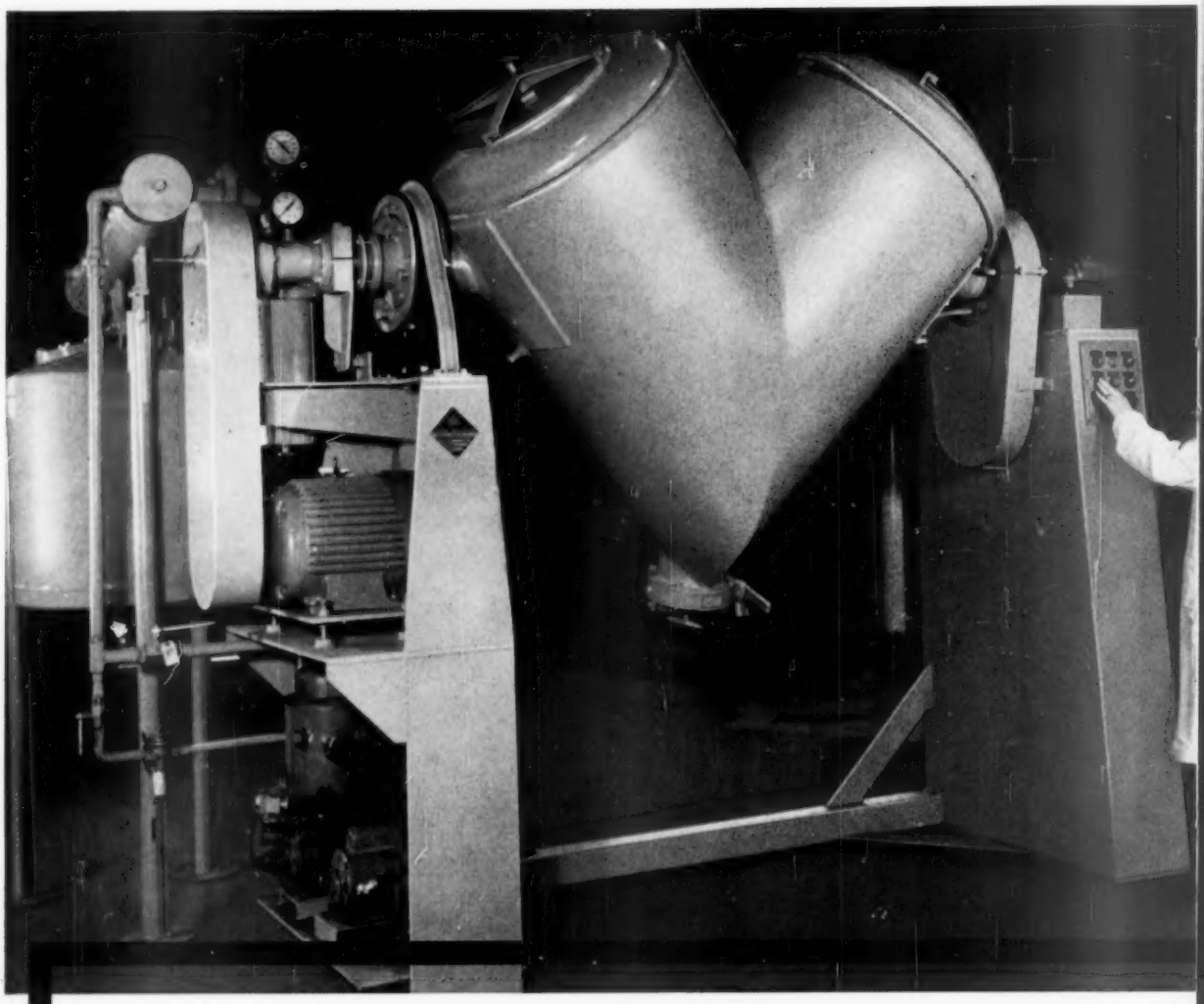

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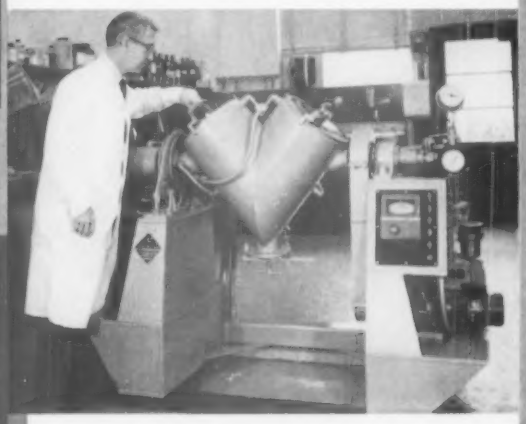

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sion cost was realized by the use of the beta amylase present in the barley. Considerable variations in syrup composition can readily be achieved by proper enzyme selection. Malting barleys appear to be better adapted for syrup production than non-malting barleys.

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THE COMPLEMENTARY EFFECTS OF THERMAL ENERGY AND IONIZING ENERGY ON PEROXIDASE ACTIVITY IN GREEN BEANS

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Peroxidase activity was studied in green bean purée exposed to a temperature of 140° F for varying periods of time, exposed to doses of 800 KVP electrons from 0.5 to 3.0 megarad, and to a combination of the two types of energy, in order to determine whether a complementary effect exists and whether the order of application of the particular energy is a factor.

Statistically valid data are presented which demonstrate a complementary effect that is not dependent upon the order of application of the two types of energy.

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THE ACTION OF AN ENZYME FOR THE FLAVOR ENHANCEMENT OF LEGUMES

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A microbial enzyme has been prepared which enhances the flavor of processed legumes. This enzyme preparation catalyzes a reaction which forms carbonyl compounds from the substrate. The reaction which occurs over a wide pH range and at temperatures below 35° C is an oxidative one as indicated by the requirement for oxygen. The action of this enzyme on increasing the carbonyl content of legumes and chemical compounds and on flavor improvement of legumes will be discussed.

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STUDIES OF THE ENZYMES AND METABOLITES OCCURRING IN FISH

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Although much information dealing with chemical composition and physiology of fish is available, intermediary metabolism of fish has not been widely studied. With the viewpoint that tissue composition and post mortem enzymic changes are directly related to metabolic processes, the objective of the present investigation is to map out the overall pathways of intermediary metabolism in fish. This fundamental approach of defining enzymic and intermediary metabolite composition in addition to the more well known proteins, lipids, etc. will be of value in food processing preservation and utilization.

The presence of surviving enzymes is of great importance in quality changes of fish products in refrigerated storage.

The work has been organized around major metabolic divisions: carbohydrate metabolism, including the Emblen-Meyerkof pathway and the hexose-monophosphate shunt; fat metabolism and β-oxidation; and terminal oxidative processes, including the tricarboxylic acid cycle, the electron transport system and exudative phosphorylation.

The demonstration of the existence of particular pathways has been accomplished by means of various techniques commonly used in the study of intermediary metabolism, such as specific enzymic assays, the ability of tissue preparations to oxidize metabolic intermediates, analysis of product formation and radioisotopic tracer techniques.

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ACTION OF BACTERIAL LIPASES ON NATURAL FATS AS DETERMINED BY GAS CHROMATOGRAPHY

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Considerable quantitative differences in lipolytic activity, as measured by titratable acidity, exist among different bacterial species. The present study was carried out to determine whether there was also a qualitative difference in the fatty acids liberated by these bacteria from lard and other natural triglycerides.

Several strains of bacteria, all of which were capable of growth at temperatures near 0° C, were grown in a peptone medium and the lipase activity of the supernatant determined. The free fatty acids were determined by gas chromatography. The percentage composition of the free fatty acid fraction hydrolyzed from lard showed higher concentrations of oleic and linoleic acids than were present in the original lard. There were no apparent differences among the strains of *Pseudomonas* included in this investigation. Neither the pH of the production medium nor the temperature had any apparent effect on the specificity of the lipase. Lipase activity was evident at −3° C within 2 to 4 days. Similar results were obtained with other naturally occurring fats and oils.

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THE CHEMICAL COMPOSITION OF BEEF PROTEIN FRACTIONS BEFORE AND AFTER IRRADIATION

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This study is chiefly concerned with the protein fraction, prepared as described in a previous report, which gave the "wet dog" odor when irradiated. It was found to contain over 16% nitrogen, 0.3% sulfur and 0.2% phosphorus. Gamma irradiation increased the amount of ammonia nitrogen that could be determined after hydrolysis and decreased the sulfyhydryl content. Phosphorus became dialyzable after irradiation of the protein. Increased absorptions at 260 and at 280 mmc not attributable to the Tyndall effect were also observed.

The solubility behavior of the fraction suggested that it was a glucoprotein. This observation was supported by the isolation of a nitrogen containing polysaccharide. It was also shown, by an ion exchange procedure for the quantitative analysis of amino acids, that the fraction corresponded closely to gelatin.

Irradiation caused a decrease in the content of nearly every amino acid, glycine, proline, alanine, histidine, glutamic acid and aspartic acid being most pronounced. The losses of cystine and methionine were not quantitatively impressive. The increase in the ammonia content was sufficient to account for the total amino acid losses. The amino acid content of two other beef protein fractions which did not give the "wet dog" odor was found to be markedly lower in glycine, alanine and proline and higher in phenylalanine and tyrosine.

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A STUDY OF PHYSICAL AND CHEMICAL CHANGES IN BEEF PROTEIN CAUSED BY LYOPHILIZATION

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The purpose of this study was to obtain information relative to differences found in a hot water-soluble, non-dialyzable fraction of fresh and lyophilized beef. Information was obtained by means of electrophoretic mobilities, ammonium sulfate fractionation and amino acid analyses of the particular fraction from compared meats. Raw, lyophilized raw, cooked and lyophilized cooked meats were evaluated. A commercially lyophilized beef product was also included in the study.

Differences were observed in the physical characteristics of the fraction investigated on lyophilization. The electrophoretic mobility values obtained on buffered solutions at selected pH levels point to areas of dissimilarity. With the ammonium sulfate levels used for fractionation, a variation in the precipitates was found. Hydrolysates of each compared fraction were investigated for variations in amino acid content.

The differences found in the characteristics of this hot water-soluble protein fraction may explain, in part, the texture changes which occur in lyophilizing of beef.

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THE PROXIMATE COMPOSITION OF PACIFIC OCEAN PERCH AND NINE OTHER SPECIES OF ROCKFISH

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Pacific Ocean perch and other rockfish represent an important part of the Pacific Coast fresh and frozen fish industry. There is very little data, however, in the literature on the chemical composition of rockfish flesh. Chemists at the Seattle Technological Laboratory of the Bureau of Commercial Fisheries have determined the composition of over 300 specimens representing 10 different species of rockfiesh collected over a period of 5 years.

Rockfish are high in protein and low in both oil and sodium. They compare favorably with other marine fish, as well as with

fresh-water fish. The composition of the different species is quite uniform regardless of the size of specimen, method of capture, or manner of preservation. The data are not considered fully adequate to evaluate the influence of season and area of capture on composition but the effect definitely appears to be minor. When the fish are frozen, iced, or prepared as commercially frozen fillets the composition remains about the same. Pacific Ocean perch and other rockfish, which are economical and abundant on the West Coast are also a highly nutritive source of food.

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THE CHEMICAL COMPOSITION OF RAW, PRECOOKED, AND CANNED TUNA. I. CORE SAMPLING METHODS

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The core sampling method provides a rapid and economical procedure for obtaining samples from tuna for chemical analysis. An attempt has been made to determine the minimum number and size of cores which would give a representative analysis of a large number of fish.

Two sizes of cores, 1 x 2 inch, and ¾ x 1½ in, were taken from the right and left sides of groups of 6 fish. The remaining edible flesh was also composited for analysis. Each sample was analyzed for: moisture, oil, protein, ash, sodium, potassium, total volatile base, free fatty acid, and the thiobarbituric acid test for rancidity.

The results indicate that four ¾ x 1½ inch core samples taken from designated parts of each fish in a representative sample of a series of fish should give a reasonably accurate analysis of the composition for the group of fish as a whole. The expected accuracy of values will be good for moisture, oil, protein, ash, sodium, and potassium; fair for total volatile base, and free fatty acid; and poor for the thiobarbituric acid test.

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EFFECT OF VINYL FILM PACKAGING ON PALATABILITY OF FROZEN TURKEY FRYER-ROASTERS

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The palatability and acceptability of certain frozen foods in storage may be significantly affected by the rate of oxygen permeability of a packaging material. This study was designed to compare the palatability of stored, frozen turkey fryer-roasters packaged in three experimental types of shrinkable vinyl films with a relatively wide range of oxygen permeability. All of the birds were processed under commercial conditions, including subscalding at 140° F (60° C) and chilling in slush ice. The turkeys then were packaged, frozen in a blast freezer at −30° to −35° F (−34.4° to − 36.1° C) and stored at approximately 0° F (−17.8° C). Reference samples were packaged in a commercially available shrinkable vinyl chloride-vinylidene copolymer film, 1.5 mil.

The palatability scores of the birds packaged in all three experimental types of vinyl film remained exceptionally high for the storage periods up to 12½ months.

There were no significant differences in the taste panel scores among any of the samples of the white meat, dark meat and skin, respectively, at any of the storage periods.

No noticeable changes in appearance were observed among any of the birds after thawing and prior to cooking at any time during this study.

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THE EFFECTIVENESS OF SELECTED FILMS FOR FRESH BEEF COLOR STABILITY IN SELF-SERVICE RETAIL DISPLAY

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The retention of attractive meat color in self-service retail meat cases continues to be a challenge to the meat merchandiser. A study was made of the effectiveness of different packaging materials for the maintenance of desirable fresh beef color under self-service conditions. Color changes of carefully selected beef round steaks were recorded with the Gardner Color Difference Meter after 1, 2, and 3 days of self-service case storage. The oxygen transmission of the test films was determined under wet conditions. Saran, the most impermeable test film, was the least satisfactory for fresh beef color stability. MSAT 80 Cellophane, SS75 Pliofilm and four Polyethylene films of different thicknesses and densities were relatively more oxygen permeable and more effective in maintaining bright red beef color. A small difference in self-service case temperature was associated with a notable difference in desirable color stability.

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DETERMINATION, IN EGG WHITE, OF LIPIDS AND THEIR EFFECTS UPON PERFORMANCE

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The monomolecular film test for determination of fat in egg whites (Berquist and Wells, 1956) was investigated.

It has been found that while increasing amounts of natural whole egg yolk will result in increasing linear increments of film area (1 sq in per 1 gamma), the individual lipid components do not result in identical monomolecular film areas, and proportions of yolk lipids other than in their natural ratio cannot be determined by this test.

In relation to the areas of other yolk lipids, the monomolecular film area of yolk triglycerides is exceedingly small and increased amounts of this lipid do not appreciably increase the film area. Further, increased amounts of this lipid interfere with the normal monomolecular film area of other lipids present.

The presence of triglycerides in egg whites can be shown to be a cause of failure in making angel cakes.

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EFFECTS OF DIFFERENT THAWING TEMPERATURES ON FROZEN CONCENTRATED MILK

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The effects of different thawing temperatures on 3:1 frozen concentrated milk were investigated. The frozen concentrated milk, packed in rectangular 5-gallon steel cans, was thawed at each of three ambient temperatures, 50, 70, and 90° F. Organoleptic tests were performed to compare the reconstituted milk products with fresh whole milk. Bacterial plate count and methylene blue oxidation-reduction time were determined for concentrated milk thawed at 90° F. Statistical analysis of the organoleptic test results indicated that no significant flavor difference can be detected between fresh whole milk and the reconstituted product. When thawed at 90° F, the concentrated milk may have a bacterial plate count high enough to result in a product of borderline acceptability.

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PRINCIPLES OF INDUSTRIAL ENGINEERING IN A FROZEN FOOD PLANT

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Case study of industrial engineering in a small plant. Any company, regardless of size, can benefit from one of Management's tools—industrial engineering. Smaller companies often complain that such a tool is too expensive, not realizing that this tool can be tailor-made to their needs and means. Measurement as the key to production control is a tool that no company is too small not to be able to afford. Sacramento Freezers Inc., one of the many small companies that comprise the small business of our country, felt that it could not afford the tool of industrial engineering, although it recognized its value. The need was so great it decided to use industrial engineering without the expense of an Industrial Engineering Department. The company used instead its supervisory personnel and, with training, was able to apply measurements throughout the production lines and set labor standards which served as guides for control in production. This resulted in reducing waste in raw product, equipment, manpower and supplies. Measurements or labor standards do not have to be as precise and accurate as we know them in industrial engineering to serve as guides in production lines. A loose measurement or labor standard is far better than no measurement at all, because such measurement can serve as a guide and be further refined until such measurement becomes a good labor standard according to industrial engineering standards.

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ECONOMIC EFFICIENCY IN FOOD PLANT OPERATIONS

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Although the food marketing and processing industry is an important sector in the national economy, it is largely unexplored by the economist and the industrial engineer. Food technologists have in general been preoccupied with the important problems of preservation, quality control, and new products. Engineers have served the industry well in developing an amazing array of mechanical equipment, carried to the point of semiautomation in some operations. Aside from this mechanical development, however, there has been little systematic application of the tools (economic and engineering) of the field that has come to be known as operations research.

Yet opportunities to increase efficiency and reduce cost through organization studies are great. They include such areas as the layout and integration of stages and operations within a plant, the selection of products, and (within the limits imposed by crop agriculture) the scheduling of receipts of raw product and the shipment of finished goods. In a broader sphere, these problems encompass the relative costs of plants of alternative type and size, the combination of plant and transport costs to achieve minimum combined costs, the integration and geographic distribution of inventory and distribution warehouses, and the complete facilities planning to serve an integrated firm or a whole producing region. When combined with studies of consumer demands, population trends, and farm production and supply, these studies provide insights into the nature of interregional competition and the future evolution of the geographic organization of the industry.

The three papers that follow in this panel make no pretense at exploiting the entire field. Rather, they stress those aspects which are most intimately associated with the internal organization of a plant or a single firm. The first illustrates the manner in which public agencies such as the agricultural experiment stations and the U. S. Department of Agriculture are contributing to improved efficiency in the food industry through research. The second suggests how management of a firm of moderate size makes effective use of industrial engineering techniques. The final paper deals with the relatively new activities of the Agricultural Extension Service in this field in bringing research results and techniques to the aid of management where the individual firm may be too small to justify a full-time staff of engineers and economists.

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THE MILITARY LOOKS AT FREEZE DEHYDRATION ECONOMICS AND ENGINEERING

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The economics and broad engineering aspects of freeze-dehydration as applied to selected meat products are discussed. One example of cost appraisals and of plant engineering will be with reference to the processing daily of cooked, steak-sized portions of beef sufficient for one million servings. This level of processing will involve the removal of approximately 20,000 lb of water vapor per hour.

The appraisals relative to the above plant will include systems recommended for use, capital cost estimates, operating cost appraisals and other economic and engineering data. A plant of contrasting size to process and serve 10,000 portions per day is also discussed from the standpoint of design and costs.

Salient product, engineering and systems factors will be considered and commented upon. Unresolved problems will be highlighted for future consideration.

Comparison will be made between freeze-dehydrated, frozen, and canned heat-processed products with reference to processing costs, transportation and packaging costs applicable to contrasting geographical locales.

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ECONOMIC-ENGINEERING RESEARCH IN FOOD PROCESSING PLANTS

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Economic-engineering research employs tools and data from the disciplines of economics, statistics, accounting, engineering and various technical sciences in studying methods of reducing costs and improving efficiency. Basic to the application of these techniques is a thorough understanding of some important characteristics of production processes—in particular, the nature of product and materials flow, the organization of production into interrelated "stages" or plants within a plant, and variations in output in both the rate and time dimensions.

Research procedures involve, first, the development of performance and cost standards. Heavy reliance is placed on the work measuring techniques of the industrial engineer—time study, work sampling, standard data, various types of description and analysis charts—and on statistical analysis of detailed plant records of labor input and product output. Estimates of other costs or input-output relationships may involve either direct analysis of accounting records or synthesis based on technical data.

These standards serve as building blocks which are used to construct descriptions of physical production systems from which cost relationships are estimated. The estimates may be used in existing plants to determine efficient crew organizations, in planning product mix, in forecasting profits, in scheduling inputs and outputs, and in considering modifications of plant and equipment. For plants in the planning stage, the research results aid in the selection of efficient techniques, in determining efficient plant size and location, and in total investment decisions. Economic-engineering methods are being widely applied in empirical studies.

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THE EXTENSION SERVICE AS AN AID TO MANAGEMENT

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As a result of the increasing complexity of technology, industrial management in the agricultural industries is finding it increasingly difficult to keep abreast of the relative profitableness of new methods and innovations. Management recognizes this problem and thus calls upon the Extension Service for advisory assistance.

The goal of the specialist is to facilitate the increasing of efficiency of the entire marketing system. Helping individual firms obtain maximum return from expenditures made in the marketing process is one method of achieving the desired goal. A highly trained specialist can "weld" the "economic-engineering" data developed by the scientists, engineers and economists into a set of "building blocks," which provide the basis for helping management to predict the outcome of alternative policy decisions.

Much of the specialist's work deals directly with the study of the firm's operational problems. Frequently, complex and interrelated sequences of activities must be analyzed in the process of determining whether or not the firm is using the most efficient approach and if new methods or innovations can be economically justified. Also, the specialist is in a position to assist management in the practical interpretation and evaluation of the research data developed by the agricultural experiment stations and the United States Department of Agriculture. Similarly, the Extension Service worker can keep the researchers informed on the problems that firms are encountering in applying research results to production line operations.

An experienced specialist tends to develop a "feel" for the operational problems, which grows out of his familiarity with the underlying factors affecting different firms. He can thus in assisting individual firms consider the basic estimates from which management calculates profit and soon limit the alternative solutions to a few most probable ones. This speeds the analysis process and increases the probability of management being able to wait for the results of an analytical study before making decisions regarding the selection of alternative work methods, installation of innovations, expanding plant capacity, or moving to a new location.

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RECENT ADVANCES IN AUTOMATION IN WHOLESALE BAKERY OPERATIONS

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Recent improvements in mechanization and processing methods in large wholesale bread baking operations are reviewed. Improvements in automation of the ingredient handling and scaling operations have reduced the labor requirement and the chances for scaling error. Centralized control panels for the entire ingredient scaling operation reduce the human factor to a minimum. Formula information is being stored on punch cards and similar coded devices, for direct infeed to the control panel.

Progress in the mixing and scaling operation continues, with improvements in continuous, semi-continuous and batch operations. Automatic decision-making equipment now available makes practical much closer control of the finished bread weight.

Chief improvements in the proofing and baking operations are in mechanical handling, with little or no change in principle, in spite of recurrent talk of dielectric and infrared baking.

Major improvements in wrapping center around handling of the polyolefin films on new, versatile equipment.

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COMPARATIVE COSTS OF FRUIT JUICE AND PUREE DRYING PROCESSES

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In the last 10 years, 5 distinct methods of producing fruit juice powders have been publicized: vacum shelf "puff" drying, spray drying, continuous vacuum drying, foam mat drying, and the concentration-flaking process. Only continuous vacuum drying of fruit juices and purees has been adapted to commercial practice. An estimate of equipment cost, labor costs, and utility costs was made for a production of 400 lb/hr of tomato powder and orange juice powder. Consideration was given to end product color, flavor, stability, and solubility. Advantages and disadvantages of process equipment were studied.

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OPERATIONAL FACTORS INFLUENCING THE EFFICIENCY OF FREEZE DRYING

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Virtually all expressions for the efficiency of freeze drying of food products reflect an interaction involving the material being dried, the equipment used, and the processing conditions. In addition, compensation must be made for the sequence of phases which characterize the drying process. Phase I terminates with the sublimation of superficial ice. Phase II represents the sublimation of ice through an ever-increasing shell of semi-dry tissue which offers resistance to transfer of heat and vapor. Phase III accounts for the evaporation of moisture adsorbed or otherwise held unfrozen by the product. In the preparation of several fully cooked meat products observations indicate that evaporative freezing may reduce the time and work requirements for freeze drying without apparent deterioration of quality. Under standard commercial conditions, the slow withdrawal of moisture during phase III is a serious deterrent to efficiency. Improved understanding and processing guidance for this phase of drying can frequently be developed from an examination of the equilibrium relative humidity relationships of the product in question. With meat products, heat denaturation appears to produce a small but consistent reduction in moisture level at equal vapor pressures.

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FOAM-MAT DRYING OF ORANGE AND TOMATO

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Foam-mat drying provides a method of producing instant powders of good quality from liquid food concentrates by air drying. Among these foods are orange and tomato. Recent developments have included several practical techniques of dispersing small proportions of glyceryl monostearate or other foam stabilizer in the foods. The mixtures are whipped to stiff foams. These foams have been spread on various surfaces as thin layers or as small extruded pieces. They have been dried in circulating air at temperatures between 130° F and 190° F. The drying times have depended only on the maximum distance to a free surface from within the foam and on the foam temperature. Residence times in the air stream have been as low as 6 minutes. Product bulk densities have varied from 0.2 to 0.8 g/ml, depending on treatment after drying. Informal taste panels have judged both orange and tomato powders satisfactory. Preliminary cost estimates indicate that both powders can be economically produced by this method when commercial-scale equipment is available.

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PURE VITAL WHEAT PROTEIN (GLUTEN)

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The present trend toward high protein foods has created a demand for powdered, dry, quality pure vital wheat protein having new characteristics.

The manufacture of such a product requires a continuous single pass drying process having the shortest possible time vs temperature cycle.

The new spray process not only fulfills these requirements but also simplifies operations and reduces cost by eliminating the need for extensive grinding of the finished product. In order to employ spray drying, uniform feed atomization is necessary. When ammonia is added to raise the pH of a water-gluten mixture to 9.5–10, in the presence of intense mechanical agitation, a free flowing suspension results. This dispersion is stable, can be pumped without difficulty and is easily atomized with conventional spray nozzles selected to produce a powder of the desired fineness.

The protein suspension is instantaneously dried in a high velocity horizontal spray dryer, using an inlet air temperature of 450° F and an exhaust air temperature of 190° F.

During the instantaneous drying cycle the ammonia dispersant is completely stripped from the product and the individual particles of pure protein, while airborne, quickly pass through the sticky, gelatinous state into the dried powder form, containing 4–6% moisture.

The dried product, a fine, white, free flowing powder, containing 80–83% pure protein retains all of the quality characteristics of the native vital gluten.

This new product possesses exceptionally high vitality, is unusually resistant to oxidative rancidity, retains its reconstitutive properties over long periods of time, and when used as a baking additive results in extraordinarily large loaf volumes.

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FURTHER STUDIES ON EFFECTS OF GAMMA RADIATION ON STORAGE LIFE AND QUALITY OF CERTAIN FRESH FRUITS AND VEGETABLES

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Studies conducted in 1958 and 1959 on apricots, sweet and sour cherries, peaches, black raspberries, broccoli, grapes, yellow sweet corn, green beans, tomatoes, and strawberries, in general, indicate that the organoleptic quality of gamma irradiated (1 to 5 x 10^5 rads) vs non-irradiated products was nearly the same. However, the quality scores, adjusted by multiplying the actual taste preference score by the per cent survival of non-moldy, edible fruit were progressively higher as the radiation dose advanced, which would indicate that radiation inhibited mold growth and thus extended the storage life of these products. Radiation rate and radiation temperature have not shown significant and consistent effects on fruits and vegetables studied.

Some of the can lining films such as 50 Mylar C seem to have some promise to products when stored in this film, prior, during, and after irradiation. The condensation of water was less and consequently less mold growth and less deterioration.

Pre-irradiation treatments with mold inhibiting chemicals such as sorbic acid, Captan, D.H.A–S, and Dowcide A, seem to be advisable because all the microbial population was not inhibited by radiation alone.

The keeping quality of strawberries and sweet cherries at 40° F can be increased by radiation up to 15 to 30 days, respectively. However, the nonirradiated controls became moldy and unacceptable at the end of 15 days storage for strawberries and 40 days for cherries. In general, 2 x 10^5 rad dose was the optimal for the preservation of strawberries and apricots; and 3 x 10^5 rad for sweet cherries without much loss in quality. Kasuga and Sparkle strawberries, and Bing sweet cherries were more suitable varieties for radiation treatment than any other studied. The green tip stage of maturity of strawberries and firm ripe stage of maturity of cherries were idea stages for radiation preservation. Unripe green strawberries, when irradiated, did not ripen, but if they were over-ripe they became soft and spongy.

Hormodendrum was the predominant mold observed on strawberries, sweet cherries, and apricots. In addition, *Botrytis* was also prominent on strawberries and *Alternaria* on sweet cherries. *Aspergillus, Penicillium, Rhizopus,* and *Stemphylium* were found in lesser degree. Growth of *Penicillium* was substantially inhibited by gamma radiation. *Hormodendrum* growth on strawberries was not controlled by the radiation alone, but by the combination treatment with 2% Captan.

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QUALITY OF MECHANICALLY HARVESTED RED CHERRIES

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Progress in mechanizing the cherry harvest has been excellent. In all orchards tested, cherries were removed from trees quickly and quantitatively by a tractor-powered shaker. Recoveries averaged 95%, a figure identical with that obtained by the present hand-picking method.

Quality varied with the orchard and with the harvesting technique. In some orchards quality of mechanically harvested fruit was equal or even superior to that of regular hand-picked fruit. In other orchards the opposite was true. Quality depended mainly on excellence of fruit on the tree and on the amount of bruising incurred during harvest. Only minor bruising occurred during the 3 fundamental, essential steps of (1) mechanical shaking, (2) falling through the tree, and (3) striking the collecting cloth. In some tests, however, bruising was excessive, owing largely to faulty collecting equipment and improper handling procedures. With improved collecting equipment and handling, bruising was less than that of hand-picked fruit.

Quality of harvested fruit was maintained best by promptly placing the fruit in cold water in the orchard. Samples handled in lugs usually developed scald blemishes. From 2 to 7% of the harvested cherries had stems. The amount of trash (dead leaves, twigs, etc.) which fell with the cherries was trivial.

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FACTORS AFFECTING THE QUALITY OF CANDIED WHOLE KUMQUATS

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Candying whole kumquats is a lengthy procedure involving the absorption of sufficient sugar by the fruit from syrups to permit preservation. Highest quality finished products are those having a light orange color similar to the fresh product, their original form with unbroken skins, and a fresh, pleasant flavor. Shortening the procedure and clarification of the effect of various factors on the quality of the final product were the purposes of this investigation.

Storage of excess fruit before processing, temperature and length of blanching, splitting of fruit, puncturing of fruit, temperature of syrups, sugars employed in making syrups, and shrivelling of fruit during soaking were some of the factors and phenomena studied.

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STUDIES ON THE DRAINED WEIGHT OF FROZEN RED CHERRIES

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A study was made of the following factors relating to the drained weight of red cherries: (1) rate of freezing, (2) concentration of sugar in contact with the fruit, (3) size of container, and (4) delay following thawing.

A high drained weight was obtained only when the fruit had been in contact with sugar or high brix sugar sirup for sufficient time to absorb about 5% of sugar. A study of the weight changes in pitted cherries during freezing and for one day following thawing showed that the system did not attain equilibrium.

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THE EFFECT OF BRUISING ON THE STRUCTURE AND PHYSICAL PROPERTIES OF RED CHERRIES

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When raw cherries are allowed to stand or "age" in air before canning, the canned cherries are firmer and have a higher drained weight than do untreated cherries. When the cherries are bruised before the ageing period, the drained weight varies with the degree of bruising. As the severity of bruising increases, the drained weight first increases to a maximum and then decreases. Microscopic studies show that the cell walls of the firm, high drained weight cherries tend to be more rigid and adhere to each other more than do the cell walls of untreated cherries.

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SPECTROPHOTOMETRIC DETERMINATION OF SORBIC ACID IN APPLE CIDER

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The UV absorption curve in the range of 250 to 300 mmc for fresh apple cider will be discussed. This UV absorption curve for fresh apple cider shows reduced UV absorption at 263 mmc. Apple cider containing sorbic acid has a peak absorbance at 263 mmc. This difference in UV absorbance at 263 mmc can be used to determine the sorbic acid content of fresh apple cider. A comparison of the direct sorbic acid determination method for cider and the sorbic acid distillation procedures will be discussed.

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STUDIES OF CHEMICAL CHANGES ASSOCIATED WITH DETERIORATION OF DOMESTIC DATES

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Domestic dates are allowed to dry before harvesting and are neither blanched nor sulfured during processing. Consequently, they would be expected to deteriorate by both enzymic and non-enzymic pathways. Studies in which blanched and unblanched dates were stored at 120° F in air or nitrogen previously confirmed this prediction, and further demonstrated the roles played by various enzymic and non-enzymic reactions in deterioration. Similar studies have been conducted at 83° and 100° F and temperature coefficients of these reactions have been calculated. It was possible to demonstrate two different temperature coefficients for those reactions, which proceed by both enzymic and non-enzymic pathways (by rate measurements in which blanched and unblanched dates were used). As expected, only one temperature coefficient was obtained for those reactions which proceed by a single pathway, either enzymic or non-enzymic. These temperature coefficients permit the rates of the various deteriorative reactions to be predicted over the temperature range studied, and also allow the energy relations of the reactions to be compared.

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EVALUATION OF NEW STRAWBERRY VARIETIES FOR FREEZING AND PRESERVING

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Because differences in strawberry processing quality may be due to seasonal variation and growing area, two or more pickings from plots in sections of Washington were compared. Berries were sliced, sugared, and frozen for later evaluation. Preserves were made from frozen fruit by standardized methods. Varietal and seasonal differences were noted in ascorbic acid, total acidity, soluble solids, and solids-to-acid ratio; the trend among varieties fell in similar order from season to season. Subjective appraisal of frozen berries indicated that the most desirable selections had a "lively" red color, identifiable slices, firm but not rubbery texture, and a balance of sweetness, acidity, and aromatic character. Greater differences were sometimes found between samples of the same variety in different areas than between varieties from a single area. Preserve factors considered were flavor, wholeness of fruit, and color stability. New selections compared favorably with the Marshall variety for preserving.

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FACTORS CONTRIBUTING TO THE BREAKDOWN OF FROZEN SLICED STRAWBERRIES

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An increasing concern in recent years by consumers and by the strawberry industry about the breakdown in character of frozen sliced strawberries led to an investigation of the basic causes of this condition. The objectives were to study the effects of: variety; time of harvest; mold inhibitor sprays; holding time and temperature after harvest; rate of freezing; method of slicing; and time of mixing of fruit and sugar on quality of the thawed product. Chemical and physical tests were performed on the fresh, prepared and thawed frozen fruit to determine the magnitude of changes and differences in lots of fruit, and between treatments on large lots of fruit.

Despite the good weather during the harvesting period there were variations in the firmness of fresh fruit of any one variety. Variety, as well as time of harvest and mold inhibitor sprays, definitely affected the character of the thawed frozen slices. Condition of fruit at harvest appears to have more influence on breakdown than holding time and temperature under normal conditions in the Northwest. Although color differences were apparent in the fresh fruit after holding the firmness was not

greatly affected by holding under the conditions of this experiment.

Rate of freezing had far less effect on breakdown than method of slicing and time of mixing the sugar and fruit. The highest percentage of breakdown of sliced fruit occurred when the mixing time was prolonged beyond the time necessary to obtain uniform mixing of sugar and fruit before freezing.

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THE RELATIONSHIP OF APPLE MATURITY TO APPLESAUCE QUALITY

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The evaluation or prediction of apple maturity at harvest time or in storage following harvest has been subject to considerable error in some seasons. In this report, heat unit accumulation and soluble-solids ratio are suggested as maturity indices and are compared with established measures of apple maturity, including calendar date, days from full bloom, and pressure test. Since apples for processing were under study, apple maturity was finally evaluated in terms of applesauce quality.

Rhode Island Greening and Baldwin apples, which are major processing varieties in New York State, were harvested at intervals in 6- to 9-bushel lots and placed in common and/or cold storage during the 1957–1959 seasons. Fifty-five pound lots from each harvest and storage were processed in a continuous pilot-plant applesauce line. Sauce quality was determined objectively using laboratory tests for color, flavor, consistency, and grain. Subjective evaluation was done by an official processed products inspector.

Results showed that pressure test was not changing rapidly enough at harvest time to provide a reliable indication of when to pick. However, for apples ripening in storage, the pressure test did prove to be a reliable index of maturity. Heat unit accumulation and soluble solids-acid ratio correlate well and are better indices of maturity at harvest time. Moreover, the continuing accumulation of heat units in storage at a known rate permits prediction of the date of desired maturity for processing.

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HEATING PATTERNS IN CANNED BERRY FRUITS DURING STILL PROCESSING

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Canned berry fruits are often unattractive in appearance, of poor texture, and possess low drained weights. Quality improvement seems to depend on reducing the amount of heat given these products during processing and storage.

Heat penetration studies were made on water and syrup packs of cranberries, blueberries, blackberries, raspberries and strawberries. This paper shows the heating patterns found for these fruits processed under non-agitating conditions at atmospheric pressure. The need for a large safety factor in the process time is discussed in terms of the wide variation in heating rates found in some of the above products.

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DEVELOPMENT AND INHIBITION OF OXIDATIVE RANCIDITY IN FOODS

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Fundamental causes of oxidative rancidity in fats and fatty foods are reviewed and the role of pro-oxidants and complex systems is discussed. Theories underlying antioxidant function reveal how oxidative rancidity may be inhibited in fats and some fatty foods. Antioxidants behave differently in different systems and an antioxidant mixture must be tailored to its requirement. Examples are given of the direct and indirect applications of antioxidants in many segments of the food industry.

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SOME BIOLOGICAL ASPECTS OF FAT DETERIORATION

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Mechanisms by which fats or the fatty constituents of food autoxidize and cause deterioration in quality, either through the accumulation of their own decomposition products or by coupled oxidations of flavor, color or vitamin constituents, have been the subject of much study. Some of the more biological aspects of this subject of current interest will be touched upon, including the action of lipid hydrolysing and oxidizing enzymes, the *in vivo* and *in vitro* activities of the tocopherols and other antioxidants, the interaction of oxidized fats with proteins and the 'toxicity' of oxidized and polymerized fats.

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THE FATTY ACID CONTENT OF THE LIPID OF SPINACH

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The lipids of spinach, Heavy Pack variety, were fractionated into the following lipid classes, namely: phospholipid, neutral fat, free fatty acids, and unsaponifiable material. The fatty acid composition of the first three fractions was investigated by means of vapor phase chromatography. The effect of storage at 0° F on the unblanched material as contrasted with that of the blanched material was determined to elaborate on the known changes which take place in the raw material, in which relatively large amounts of acids are formed during storage.

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CARBONYLS IN OXIDIZING FAT. IV. THE ROLE OF VARIOUS FATTY ACID COMPONENTS ON CARBONYL GENERATION

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Fats become rancid at widely varying peroxide levels. A primary factor in the performance would presumably be due to differences in fatty acid composition, with resulting variation in the kind and amount of carbonyls produced.

Despite a continuing interest in the subject, analyses of the carbonyls generated by autoxidized unsaturated fatty acids have been incomplete. Newly developed micro methods have been applied to the qualitative estimation of the volatile monocarbonyls produced by autoxidized alkyl esters of oleic, linoleic, and linolenic acids. These results are compared with carbonyl products obtained from animal and vegetable fats of widely different composition and glyceride structure. The monocarbonyls produced by separately oxidized acids were: Oleate: n-alkanal C_6, C_8*, C_{11}; n-alk-2-enal C_{10}*, C_{11}*. Linoleate: n-alkanal C_5, C_6, C_8*; n-alka-2-enal C_7*, C_8, C_9; n-alk-2,4-dienal C_{10}*. Linolenate: n-alkanal C_2, C_6*, C_8; n-alk-2-enal C_4, C_6*, C_8, C_7; n-alk-2,4-dienal C_7*, C_9*.

* Major compounds.

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AUTOXIDATION OF FISH OILS. I. IDENTIFICATION OF VOLATILE MONOCARBONYL COMPOUNDS FROM AUTOXIDIZED SALMON OIL

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Carbonyl compounds, resulting from the autoxidation of fat, contribute significantly to the flavor and quality of frozen, stored seafood products. This investigation was undertaken to isolate and characterize the volatile monocarbonyl compounds from autoxidized salmon oil. The procedure involved the vacuum steam distillation of oxidized salmon oil, TBA number 1796 and the collection of the volatile compounds in cold traps. The 2,4-dinitrophenylhydrazones were prepared and separated from the dicarbonyls by treatment and hexane. The monocarbonyls were separated by partition chromatography on a nitromethane-hexane-Celite column, previously described. This procedure was complemented by paper chromatography. Spectrophotometric analysis and melting point analysis were performed. The data obtained indicate that in addition to the dialdehyde, malonaldehyde, the monocarbonyls thus far identified from autoxidized salmon oil include the C_6 to C_{10} alkanals, C_8 to C_{11} alk-2-enals, C_8 to C_{12} alk-2,4-dienals.

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THE EFFECT OF METHYLATION UPON THE ANTIOXYGENIC AND CHELATING CAPACITY OF QUERCETIN AND DIHYDROQUERCETIN IN A LARD SUBSTRATE

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The purpose of this study was to relate the molecular structure of quercetin to its antioxygenic and chelating ability. The method of study was to methylate the hydroxyl groups at specific positions on the quercetin molecule and test these various methyl ether derivatives using the Active Oxygen Method. Lard was used as the oxidizing substrate. The effectiveness of quercetin, dihydroquercetin and their methyl ether derivatives was determined by addition of Cu^{++} to the oxidizing substrate. Variations in the oxidation pattern as determined by peroxide values was used in comparing the antioxygenic and chelating ability of these compounds.

It was found that the hydroxyl group on carbon three of quercetin was of prime importance in the antioxidant and chelating ability of the molecule. The unsaturation between carbons two and three is also important. The hydroxyl groups on carbons five and seven also contribute to the antioxidant and chelating ability of the molecule.

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OXIDATION OF FAT IN MODEL SYSTEMS RELATED TO DEHYDRATED FOODS. II. POSITION OF DISPERSED LIPID COMPONENTS AND ITS EFFECT ON OXIDATION RATES

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Investigation of stability of model dehydrated systems containing dispersed lipid components indicates that oxidation rates at elevated temperatures are influenced by the concentration of components, type of dispersing medium, and the position of the lipid film with respect to the dispersing medium.

Of the several dispersing media studied, the proteins—gelatin, egg white, soy protein, and ovalbumin—had stabilizing effects, while the polymeric carbohydrates—carboxymethyl cellulose (CMC), Irish moss, potato starch and dialdehyde starch—had the effect of accelerating oxidation rates of the lipids.

Oxidation rates in dehydrated emulsion systems varied inversely with the fat concentration when the fat was emulsified with the dispersing medium prior to dehydrating and directly when the fat was applied on the surfaces of the freeze-dried medium. The most stable of a number of fatty substances investigated in freeze-dried emulsions were L-arginine and L-lysine safflates. These showed very little oxidative change, development of off-odors, or browning, even in the presence of oxidation accelerating heme compounds. Nevertheless, they were normal substrates for enzyme oxidation.

Phospholipids had stabilizing influence when dispersed with the fat and the CMC prior to freeze-drying or when applied as a film between the freeze-dried CMC and the fat film. When the positions of the fat and the phospholipid films were reversed, the protective action of the phospholipid on the stability of the system was markedly decreased.

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HEMATIN CATALYZED UNSATURATED LIPID PEROXIDATION AND ITS INHIBITION BY VITAMIN E

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Hematin catalyzed lipid peroxidation is a primary pathological reaction in vitamin E deficiency and a mechanism of oxidative rancidity in fish, poultry and other meats. Comparisons of hemoglobin-catalyzed oxidation and autoxidation of a variety of unsaturated fatty acids, esters and triglycerides show that the hemoglobin-catalyzed oxidation is more rapid. At the cellular level hematin catalyzed lipid peroxidation occurs primarily in the mitochondrial and microsomal fractions. Inhibition of hematin catalyzed lipid peroxidation by vitamin E is synergized by ascorbic acid; vitamin E appears to couple to the reduction chain: ascorbic acid-glutathione-glutathione reductase-reduced triphosphopyridine nucleotide. Various products of α-tocopherol resulting from hematin-catalyzed and autoxidation of linoleate have been isolated; tocopherolquinone is a major product.

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PROPERTIES OF LIPIDS THAT INFLUENCE STABILITY OF SALAD DRESSING TYPE EMULSIONS SUBJECTED TO FREEZING

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A mayonnaise-type salad dressing that can be frozen without separation on thawing has been sought by commercial producers of salads and sandwiches to make possible a greater variety of foods that can be frozen in quantity and thawed just prior to use. This research was conducted to determine under what conditions such products containing emulsions can be frozen without subsequent separation of lipid or water phases. The interrelation between solidification temperatures of the component oil fractions and storage temperature is of primary importance to production of a stable product. The influence of concentration and previous history of the egg yolk used as the emulsifying agent, the stability of the original emulsion, and type of starchy thickening agent also influences stability of the product in varying degrees. Conditions required for preparation of a stable emulsion-containing salad dressing are described.

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EFFECT OF IONIZING RADIATION ON THE FAT-SOLUBLE VITAMINS

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Relative sensitivities of the fat-soluble vitamins to ionizing radiations will be discussed. Of these, vitamin E is by far the most sensitive, followed in order of decreasing sensitivity by A, D, and K. In the presence of other solutes, such as those found in natural lipids, the vitamins are more radio-resistant than in pure solution. This protective effect decreases with increasing sensitivity of the vitamin and with increasing unsaturation of the lipid environment.

Reactions of vitamin E with the free radicals produced during irradiation have been investigated and will be discussed. It is apparent that the inactivation of this vitamin by irradiation takes a different course from simple oxidation, since carbonyls, but no quinones, have been found in the products.

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CHEMICAL STUDIES ON THE AGING OF MEATS

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The studies reported are: (1) Changes of Alkaline Earth Metals in Actin and Myosin B during Aging of Meats and (2) Effects of Gamma-Irradiation on the Chemical Properties of Actin and Myosin B during Aging of Meats.

(1) The content of total alkaline earth metals and calcium in actin and myosin B during aging of meats was determined. Content of actin was found to be maximum immediately after slaughter and minimum 2 days later—perhaps at the maximum rigor. By contrast, content of myosin B was maximum at maximum rigor. The relationship between content of alkaline earth metals in meats and water holding capacity of meats during aging is discussed.

(2) Meats were irradiated with 4×10^5 rad of Co^{60} gamma rays at 40° F in three steps, i.e. immediately after slaughter, at maximum rigor, and at "rigor off."

Actin and two kinds of myosin B (AM-S and AM-L, previously reported by the authors) were isolated from irradiated and non-irradiated meats by the usual method. The content of sulfhydryl groups and amino acids, viscosity, the activity of ATPase and ATP-sensitivity of actin and myosin B were determined. From the results, actin is thought to be only slightly sensitive to irradiation as compared with myosin B, but the latter, especially AM-L (a long time-extracted myosin B) is considered to be very sensitive. The effects of the time of irradiation on the chemical properties of myosin B in meats seem to be more remarkable at rigor off than at the other two steps.

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DEVELOPMENT OF FREEZER-BURN AS A LIMITING FACTOR IN THE STORAGE OF ANIMAL TISSUE. III. ADDITIONAL TREATMENTS TO CONTROL FREEZER-BURN (ON FROZEN OFFALS)

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Freezer-burn is an unsightly light greyish patchy discoloration of the surface of frozen products which arises as the result of sublimation of quite small amounts of ice from the surface of the product. It is frequently inconvenient or uneconomic to prevent such sublimation by the use of suitably impermeable wrapping materials or jacketed storage rooms. Experiments have been carried out to study the conditions which favour the production of freezer-burn and from these the possibility of controlling freezer-burn by additional treatments has been considered.

Histological studies on samples rapidly frozen without loss of weight to a temperature of −10° C showed that the tissue condenses within the region from which ice has been removed by sublimation to form a condensed layer and the cavities typical of freezer-burn and the irreversible changes in the tissue only take place as further weight loss occurs in the condensed layer. Freezer-burn on livers can be retarded when they are stored for one week at about 2° C before freezing and also when the samples are frozen slowly so that appreciable loss of moisture occurs during the freezing. The viscid condition of the extracellular substance remaining after ice crystals had formed favoured the formation of a condensed layer rather than freezer-burn. Such conditions can also be produced or enhanced by dipping the liver in concentrated solutions of hexoses, higher alcohols, etc., before freezing. By this means freezer-burn can be completely prevented on lean livers and substantially retarded on fat livers.

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PROTEOLYTIC CHANGES IN STORED BEEF. VI. EFFECT OF PRE-IRRADIATION HEATING TEMPERATURE AND IRRADIATION LEVEL

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It has been known that during aseptic storage the flesh of animals will exhibit an increase in the free amino acid level with a subsequent decrease in the glycine soluble protein fraction. The investigators were interested in determining the quantitative increase of ten dispensable free amino acids in beef muscle during aseptic storage.

Samples of beef were pre-irradiation heated, irradiated at 5.0 megarad and stored for 200 days at 70° and 100° F. The following free amino acids in the beef were analyzed qualitatively and quantitatively using one-dimensional paper chromatography: alanine, glycine, serine, glutamic acid, aspartic acid, tyrosine, histidine, arginine, cystine and proline. Total amino acids were determined qualitatively and quantitatively before and after storage.

As storage time increased free tyrosine, free proline, free arginine and free histidine increased in quantity, while all the other free amino acids with the exception of cystine increased—then decreased. Cystine was not found in the free state.

As storage temperature increased all 9 free amino acids quantitated increased.

As the pre-irradiation heating temperature was raised all 9 free amino acids quantitated decreased.

There was only a minimum of difference in the quantity of the total amino acids before and after storage. The percentages of the free amino acids released were very low indicating little complete hydrolysis of native proteins had taken place.

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PROTEOLYTIC ENZYME ACTIVITY DURING STORAGE OF RADIATION-STABILIZED RAW BEEF AND ITS SIGNIFICANCE TO FLAVOR

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The refrigerated shelf-life of raw beef cuts is quite limited because of spoilage changes which occur during storage. Ionizing radiation has been used successfully for controlling microbiological spoilage, but not for control of spoilage due to enzyme activity. Practical control of enzyme spoilage is obtained by use of heat, but the resulting meat product is cooked, not raw. Control of tissue proteolytic activity by use of meat from epinephrine-injected animals has been reported, but the significance of the control with regard to flavor during storage has not been well-defined. The non-refrigerated storage of radiation-stabilized raw beef is characterized by a pronounced fluid exudation, by production of amino acids and peptides, and by a marked decrease in taste panel preference.

This paper reports studies undertaken to define more fully the role of tissue proteolytic enzyme systems (cathepsins) in raw beef during refrigerated and non-refrigerated storage. Data are presented which show a positive correlation between the extent of proteolysis and the decrease in taste panel preference scores. The data also indicate the degree and significance of control when proteolysis is inhibited by use of refrigerated storage or high pH (dark cutter) meats.

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THE EFFECTIVENESS OF ACRONIZE CHLORTETRACYCLINE IN POULTRY PRESERVATION FOLLOWING LONG TERM COMMERCIAL USE

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Acronize, the food grade of Aureomycin chlortetracycline, has been used effectively by the poultry processing industry for the past 4 years to retard bacterial spoilage. A study was undertaken to determine the current effectiveness of the antibiotic under continued plant use compared with its original ability to retard spoilage. Acronized and control broilers were obtained from a commercial processing plant that had been employing Acronize for several years. Chickens were held under commercial storage temperatures in the laboratory and sampled at specific intervals until spoiled. Data are presented to show microbiological counts, organoleptic evaluations and chlortetracycline residues.

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STUDIES ON THE ROOM TEMPERATURE AGING OF BEEF FOLLOWING INTRAVENOUS ANTE-MORTEM INJECTION OF ACRONIZE CHLORTETRACYCLINE

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The large volume of low grade beef obtained from retired dairy cattle is used for comminuted meat products. A study was undertaken to determine if it would be possible to improve the tenderness of that beef thereby expanding its use for retail beef cuts. The effect on tenderness of short-term room-temperature aging of slaughtered dairy cattle was evaluated. Acronize chlortetracycline applied by intravenous injection prior to slaughter was effective in preventing deep spoilage during the aging period. Acronize chlortetracycline was applied as a spray to retard surface sliming during this period. Statistical studies on improvement in tenderness from several cuts of meat are presented.

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EFFECT OF PRE-IRRADIATION HEATING ON THE FLAVOR AND NITROGENOUS CONSTITUENTS OF BEEF DURING STORAGE

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This investigation determined the pattern of changes in flavor and in amino nitrogen, trichloroacetic acid soluble nitrogen and total soluble nitrogen of irradiated precooked ground beef during prolonged storage at room temperature. Pre-irradiation heating temperatures used ranged between 130° and 170° F. Relationships between these nitrogenous factors and sensory attributes were correlated.

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TIME AND TEMPERATURE TOLERANCES IN FROZEN BEEF AND PORK

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The effects of storage temperature, length of storage, type of product, and aging period on organoleptic and chemical changes of frozen ground meat form the basis of this study. Ground meat from 3 types of product which had been aged for 3 periods of time was frozen, stored under 5 temperature treatments, and tested by organoleptic and chemical methods at 3-month intervals up to 12 months' storage.

Length of storage, storage temperature, and type of product had significant effects on the organoleptic evaluations and chemical constituents of frozen meat. Analyses for coagulable nitrogen and amino nitrogen indicated the degree of proteolysis and denaturation which occurred in the lean tissue. Although there were significant changes in these constituents which followed a consistent pattern, the changes were of such a small magnitude that it would be impractical to use these tests to ascertain the acceptability or predict the distribution life of frozen meats. The results of these analyses as well as the organoleptic data indicated little change in flavor due to protein deterioration. Two-thiobarbituric acid values support the observations from the organoleptic evaluations that changes in the fat are mainly responsible for the decrease in palatability of frozen meat.

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STABILITY FACTORS IN PACKAGED RAW MEAT

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Packages for self-service fresh meat must be non-toxic and mechanically strong and must possess properties that preserve the color of the meat. Most gas-permeable films react essentially

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alike as packaging materials for fresh meat. One means of causing fresh meat to have red color after it has been packaged for 48 hours is to use an impervious container and seal under vacuum. In headspace of such a container, the composition of gas, in respect to oxygen content, at the outset of storage, controls the rate of change of color. For a given composition of gas, which contains oxygen, the amount of gas present controls the rate of color change.

Oxygen in the gas slows down the rates of both loss and regeneration of redness. Very low oxygen content brings rapid loss and rapid regeneration of redness, followed by generally good stability of red color. High oxygen content brings a lower rate of loss of redness. Customarily there is then a slight regeneration —also at a low rate—, followed by further loss of redness. Effects of antioxidants upon color have been contradictory.

Vacuum packaging retards both bacterial and chemical (hydrolytic and oxidative) spoilage of fresh meat—particularly of ground meat. Under reasonable sanitary practice, packaged ground meat has a shelf life of 10 days.

Regenerated red color in vacuum packaged fresh beef is produced by a combination of myoglobin fractions containing from 20% to more than 50% of oxymyoglobin.

Loss of moisture and the consequent decrease in weight occur in packaged fresh meat in refrigeration for a period longer than that during which retail packages are held. Adequate packaging technics (not now available) are needed to make retail frozen meat competitive with fresh meat.

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THE EFFECT OF AN ANTIOXIDANT IN THE HOG RATION ON THE STORAGE LIFE OF PORK AND LARD

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The influence of an antioxidant in the pig ration on the potential storage life of pork and lard was investigated. In 4 experiments the quality of loin roasts, sausage, and lard from hogs fed standard rations of corn, soybean, sorghum, or wheat and the standard rations plus ethanolamine hydrochloride (50 g/100 lb ration) was measured. Roasts and sausage were stored at 0° F and lard was held in the refrigerator (36° to 40° F) and at room temperature (74° to 98° F). Samples of lean and fat from the roasts, the sausage, and baking powder biscuits made with the lard were scored for palatability at certain intervals during storage. Peroxide and free fat acid values were determined for fat on the roasts, sausage, and lard.

Storage life of roasts, sausage, and lard held at refrigerator temperature from hogs fed ethanolamine hydrochloride was no better than that of the same products from hogs fed the standard rations. When lard was stored at room temperature the ethanolamine hydrochloride had some beneficial effect in prolonging storage life. In general, products from hogs fed the soybean ration were inferior to products from hogs fed the other rations.

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STERILIZATION OF PROCESSING FACILITIES

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The problem on which this investigation was based was to heat sterilize interior surfaces of vessels and lines which are void of fittings, removable connections, or parts having minute porosity factors, where ingress and egress of carriers used for processing require recorded values without internal connections. In attacking this problem the necessary probes and external fittings were provided in order to determine the temperature differential between internal and external readings on various sizes and volumes of lines and vessels. Strategically placed thermo-couples were connected to automatic temperature recording equipment as required to develop formulas which can be used with ambient external temperatures to arrive at necessary internal sterilizing temperatures on interior surfaces of various vessels, considering wall thickness relations to volumes and materials having different coefficients of heat transfer. The effects of condensate, when using saturated heat, on specific volumes, relative to specific areas were determined in order to indicate temperature reductions due to static deposits of liquid. The relation between external temperatures and internal temperatures, with variable values, was established.

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FOULING OF HEAT EXCHANGER TUBES

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A basic study of fouling inside heat exchange tubes has been carried out. Evaporation of tomato inside long evaporator tubes has been emphasized, but simpler systems have been included. The result of the build-up of decomposition products on the hot surfaces has been separated from the result of changes in other heat transfer resistances.

Effects of wall temperature, vapor fraction, and concentration and identity of solutes in the liquid have been studied. Results have shown the importance of adequate preheating of the feed, low temperatures at tube wall surfaces, and prompt separation of vapor and liquid. No method has been found for avoiding fouling at high heat transfer rates.

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STUDIES ON THE APPLICATION OF INFRARED IN FOOD PROCESSING

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Infrared radiation, as a source of heat, has been studied for a number of applications in the food processing industry. In several cases, the use of infrared reportedly offered advantages as compared to other heat sources. These advantages differed in each particular case and varied from faster drying to improved flavor and texture. Disappointing results obtained were often due to popular misconceptions of infrared radiation, especially with respect to its penetration characteristics. The present study was designed primarily to evaluate 3 different types of high energy infrared radiators. In addition, an evaluation of several food processing applications of infrared are included, viz blanching of apples, celery and peas and the braising of stewing beef for canned stew.

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DEHYDROFROZEN APPLES: RECENT DEVELOPMENTS IN PROCESSING METHODS

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Recent studies have yielded new information on processing conditions and operations required for production of dehydrofrozen apples. Special attention has been given to the determination of conditions that will permit use of air at normal ambient humidity in the drying operation. Earlier investigations had indicated that high humidity drying was necessary. Recent tests show that high quality dehydrofrozen apples of suitably low SO_2 content can be produced without use of high humidity air. The new method involves through-flow drying of suitably prepared material. In through-flow drying of apple wedges, drying capacity per unit of drying surface is several-fold greater than that obtained in cross-flow drying. Processing requirements were studied for apples of 3 different varieties and 3 different piece sizes. Information is given on the effects of variations in sulfuring treatments. Blanching is introduced as an optional post-drying step and the possible advantages in its use are discussed. A procedure is also described for producing blanched nonsulfured dehydrofrozen apples.

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YIELD CHARACTERISTICS OF SELECTED FOOD ITEMS PREPARED BY MICROWAVE AND CONVENTIONAL COOKING EQUIPMENT

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The increasing commercial use of microwave, i.e., "electronic" or "radar" cooking devices, has made evident the need for cooking yield data as a basis of comparison with improved modern conventional electric cooking equipment. Studies have been conducted on the yields from the preparation of individual portions of food but data were needed on the preparation of food in commercial sizes, such as would be required in restaurant or institutional feeding. Special experimental techniques were devised to assure that food was cooked to comparable internal temperatures. In 55 tests of 7 different food products, higher yields were obtained from a conventional electric oven and griddle than from a microwave device except when preparing lobster where yields were approximately the same. For the conventional equipment, the yields ranged from 68.6% to 85.5% whereas for the microwave equipment the yields ranged from 61.8% to 80.7%. Analysis of the experimental data showed that except for lobster and turkey (cooked in halves), the principal difference in cooking losses between microwave and conventional cooking was that due to evaporated moisture. This was verified by examination of the food products which indicated crusting

and dehydration of the surface on products prepared in the microwave oven. It was noted that cooking times in the microwave oven ranged from approximately 40% to 70% less than for the conventional electric equipment.

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COMPARATIVE HEATING EFFICIENCIES OF A MICROWAVE OVEN AND A CONVENTIONAL ELECTRIC OVEN

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An important aspect of microwave food preparation not previously investigated is heating efficency. This characteristic was studied in comparison with an improved modern conventional electrical cooking device. Roasting of beef was selected as a typical extended-time cooking process; heating of water was selected as a short-time cooking process typical of most vegetable preparation. Using standardized techniques, water-heating experiments showed no significant difference between the efficiency of utilization of electrical energy in a microwave oven and a conventional oven, both being approximately 34%; however, the efficiency of a conventional electric hot plate was 63% or almost double that of the microwave and conventional oven. Beef, prepared under controlled conditions, to given internal temperatures, required approximately 30% more electrical energy in the microwave equipment than in the conventional oven, although the over-all electrical efficiency of the microwave oven was 33.4% compared to 36.7% for the conventional oven. This was explained by the higher cooking losses in the microwave oven. Analysis showed that the energy used to heat and evaporate moisture from the meat constituted about 60% of the total energy required for conventional roasting but constituted almost 80% of the total energy for microwave roasting. Expressed in practical terms, it took 119 BTU (input) per ounce (of yield) to prepare beef in the microwave oven as compared to 74 BTU per ounce to prepare beef in the conventional electric oven.

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THERMAL PROPERTIES OF FOODS AT LOW TEMPERATURES; I. SPECIFIC HEAT

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An apparatus and a technique developed for measuring the specific heat of foods at low temperatures (between 0° C and −196° C) are described. Knowledge of the specific heat of foods at the lower temperatures is of value for the use of liquid nitrogen in the sub-cooling of foods.

Preliminary experiments with model systems simulating the composition of foods has indicated that the specific heats of the individual components in solution or suspension are additive. The results obtained using various foods as exemplified by beef roasts, smoked ham, and fish cakes have shown that the specific heat of foods may be predicted on the basis of the percentage composition and specific heats of the components.

The effect of water binding proteins on the specific heat is also described. Increasing protein concentration decreases the specific heat of the solution. This decrease is not related linearly to dilution.

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A METHOD FOR CALCULATING THE TEMPERATURE DISTRIBUTION AND MASS AVERAGE TEMPERATURE IN CONDUCTION-HEATED CANNED FOODS DURING WATER COOLING

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It is desirable in cooling retorted canned foods to achieve a mass average temperature between 90° F and 110° F. This prevents can rusting and thermophilic spoilage. A method is described for calculating the temperature distribution curve and mass average temperature after a given cooling time has elapsed. The calculated and experimental results were found to check satisfactorily.

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CONTINUOUS PROCESS DATA RECORDING IN THE MANUFACTURE OF VEGETABLE FAT WHIPPING EMULSIONS

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It is highly desirable to control time and temperature conditions in the manufacture of vegetable fat whipping emulsions, since these conditions drastically affect the final whipping properties of such emulsions. The precise degree of control required, expressed in definite numerical values for time and temperature tolerances, can be determined by correlating "case histories" of individual production batches of whipping emulsion with their determined whipping properties. An original modification and adaptation of the Bristol Dynamaster, Wide Strip Resistance Thermometer which records these process data is described, with interior and exterior views of its component parts, diagrams of the circuits involved and instructions for modifying the thermometer and for building the auxiliary device. This modified recorder, with accompanying rotary switch resistance box, is capable of logging the following coded information: Mixing time, average mixing temperature, holding time (hot), holding temperature, homogenization time, the temperature drop across the first cooler, the drop across a second cooler, the holding time (cold), holding temperature (cold), packaging time, container size, container label, and batch number for the day. The correlation of the foregoing production data with laboratory data on final whipping properties of an emulsion furnishes a basis for establishing definite manufacturing tolerances for a given specific formulation. Typical process data, laboratory data, and tolerances for a specific emulsion are offered.

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A MECHANICAL POULTRY MEAT EXTRACTOR

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The equipment consists essentially of a rotating extractor fitted with slit screens, a brine tank and separator, conveyors, and an inspection belt. The sketches and photographs show the operation of the machine. The equipment yields surprisingly large pieces of meat. In some installations the breast, or the breast and thighs are first removed by hand. Normally, the whole fowl is machine-boned. The eviscerated bird is cooked in water for from 15 to 135 minutes, depending on what is to be done with the meat. The operation is simple, fast, and very effective. It operates equally well on fowl, roosters or turkeys. There is a considerable number of successful commercial installations in the East and Middle West but none as yet on the Pacific Coast. The equipment has been approved by the Poultry Inspection Division of the U. S. Department of Agriculture. The machined meat is of very high bacteriological quality. Yields run from 3 to 5% better than that obtained from hand-boning. Meat recovery from fowl with necks left on the bird average 36% and the volume per hour for fowl is 2,000 lb and for turkeys 4,000 lb. Commercial installations show the man-hour yield to be 22.8 lb. The bone count can be kept low with proper inspection. Salt and moisture are relatively unaffected as the meat is immersed in the brine only about 5 seconds. The equipment is used by canners, frozen pie packers, soup makers and for chicken-a-la king, croquettes, diced chicken and chicken baby-food packers. It is a substantial labor-saver.

113
THE VIABILITY OF A YEAST IN HIGH DENSITY ORANGE CONCENTRATES STORED AT VARIOUS TEMPERATURES

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A yeast which will remain viable in orange juice concentrate under commercial cold storage was studied for its tolerance to several storage conditions. Statistically planned inoculations of this yeast were made into concentrate at 60, 65, and 70° Brix and held at temperatures of 20°, 40°, 60°, and 80° F for various periods of time. Results show that this organism fermented all the samples stored at 60° and 80° F within approximately 30 days and the viable populations of the rest diminished, with one exception. In the 60° Brix orange juice concentrate stored at 40° F a significant increase took place during the entire 4-month test period. This yeast will ferment 65° Brix orange juice concentrate when stored at temperatures above 40° F.

114
MOISTURE FORMATION IN DEHYDRATED LEMONADE

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Studies directed toward improved storage stability of dehydrated lemonade disclosed that, in the absence of an in-package desiccant, moisture content increases during storage at a rate largely dependent upon temperature. Since the rate of quality deterioration in the form of browning and caking are functions of moisture content, it was of interest to locate the source of the moisture increase. It was found that the naurally-present citric acid apparently loses one carboxyl group with the formation of a molecule each of a dicarboxylic acid and water. Such a reaction occurs in the thermal degradation of citric acid at elevated temperatures (175° C), but was not expected to be significant in dehydrated lemonade stored at temperatures ranging from room temperature to 37° C.

115
INVESTIGATIONS OF THE HYDROCARBONS IN LEMON OIL

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A method of analysis for measuring the relative amounts of the major hydrocarbons in lemon oil is described. The mixture of hydrocarbons is separated from the other components by downward elution on silicic acid-coated chromatostrips. The eluate is analyzed by gas chromatography without further concentration. Four major peaks were obtained which were identified as α-pinene, β-pinene, d-limonene and γ-terpinene. Trace amounts of other hydrocarbons were found of which p-cymene was the most important.

Over 100 samples of lemon oil were analyzed for their hydrocarbon content. The correlation of differences in the optical rotation of these samples with compositional differences is discussed. Evidence is presented implicating γ-terpinene as the major precursor for the formation of p-cymene in lemon oil which gives rise to the typical "cymie" off-flavor of oxidized oils.

Analyses of the hydrocarbons in orange and grapefruit oils are included for comparison.

116
GAS CHROMATOGRAPHIC ANALYSIS OF THE MAJOR ALDEHYDES IN LEMON, ORANGE AND GRAPEFRUIT OILS

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The aldehydes present in major concentration in lemon, orange and grapefruit oils were recovered as their water-soluble Girard-T derivatives followed by regeneration with formalin and analysis by gas chromatography. Experimental conditions for recovery were studied using mixtures of known aldehydes. Optimum conditions were selected to obtain good reproducibility with a mixture containing C_7, C_8, C_9, C_{10} and C_{11} normal saturated aldehydes and citral which represent the major aldehydes in lemon oil. Analyses of the major aldehydes in lemon, orange and grapefruit oils are given, and the effects of agronomic and processing variables on the aldehydes in lemon oil will be discussed.

117
THE CARBOHYDRATES OF CITRUS PEEL

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Carbohydrates of the peel of 3 varieties of oranges and one variety of grapefruit were studied during the maturing period. Fruit harvested at monthly intervals were analyzed for their carbohydrate content. Sugars in the alcohol soluble fraction were qualitatively identified on paper chromatograms to be glucose, fructose, and sucrose with a trace of free xylose in some samples. The 3 main sugars were determined separately by usual chemical method. The seasonal changes of these sugars in the peel were noted.

Polysaccharides of the citrus peel in the alcohol insoluble fraction composed mainly of cellulose, hemicellulose, and the pectic substance fraction. The pectic substance fraction was extracted from the alcohol insoluble solids with 0.05 N sodium hydroxide and subsequently hydrolyzed with Pectinol 100-D. Arabinose and galactose were present in the hydrolysate in amounts of about 40% of that of galacturonic acid. The residual mixture of hemicellulose and cellulose was hydrolyzed by solubilizing it in 72% sulfuric acid, diluting it to 1% sulfuric acid with distilled water, and refluxing. Sugar components in the hydrolysate were identified and estimated on paper chromatograms using Butanol pyridine, benzene, and water (50:30:4.5:30 — v/v) as the irrigating solvent and aniline phthalate as the spraying reagent. Xylose, arabinose, galactose, and glucose were present in appreciable quantities. Trace of mannose was also found.

118
A RAPID METHOD FOR THE DETERMINATION OF OXYGEN IN ORANGE JUICE

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A rapid method for the determination of the oxygen content in single strength or concentrate orange juice has been developed. The apparatus used consists of an oxygen electrode with a gas permeable membrane covering the cathode which is supplied with a current of 0.6 volts which is sufficient to reduce oxygen but none of the other common gases found in orange juice. The electrode is placed in a sample of orange juice sufficiently well agitated and the current produced is measured with a standard pH meter and correlated with the oxygen content in a duplicate sample determined by a modified Orsat apparatus. The time and trouble required to determine the oxygen content is little more than running a pH determination and the results are reproducible in high degree. This procedure has been used for the past year in the Quality Control Laboratories of Minute Maid Corporation with excellent results.

119
AN ION-EXCHANGE STUDY OF THE AMINO ACIDS IN CITRUS FRUITS

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The results represent a preliminary survey of the quantitative compositions of the juices of mature Valencia and Washington Navel oranges, as well as of commercial varieties of lemon and grapefruit. The analytical procedure utilizes the method of Moore *et al*, *Anal Chem.* 30, 1185 (1958), in which the amino acids are eluted from Amberlite IR-120 columns, and determined spectrophotometrically with ninhydrin. Qualitative identification is accomplished by paper chromatography of the desalted effluent.

Over 20 ninhydrin-positive compounds were detected in the juice of the Valencia orange. Proline and arginine predominate (approximately 14 and 6 mc*M* per ml of juice, respectively), but substantial amounts of aspartic acid, asparagine, serine, alanine, and gamma-amino butyric acid are also present. Lesser mounts of valine, glycine, glutamic acid, tyrosine, phenylalanine, lysine, and the leucines appear. Some unidentified compounds are also indicated. One of these, present in substantial amounts, appears to be an amino acid. Quantitative data for the other citrus juices are also presented.

120
THE DETERMINATION OF SOLUBLE SOLIDS IN CITRUS JUICES. I. THE EFFECT OF NON-SUCROSE CONSTITUENTS ON REFRACTOMETER VALUES

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The general purpose of this study was to develop improvements in accuracy of refractometric and densimetric methods for the determination of true soluble solids in citrus juice products. The first phase of the study is concerned with the determination of the effects of non-sucrose constituents on refractometer sugar scale values.

Effects of citric acid and reducing sugars have long been known, and tables of corrections for citric acid have been published. Effects of amino acids, citrate salts, pulp, pectin, flavonoids, and peel oil were tested by dissolving or dispersing them in known proportions in water, sugar solutions, or concentrated citrus juices, and comparing refractometer values before and after addition of the test material. All six of these constituents were found to increase refractometer values, and therefore require that corrections be subtracted from refractometer readings if such values are to reflect true soluble solids. Peel oil is usually present in citrus juice products in such small quantities that its effect is considered negligible. Effects of the other constituents, including citric acid and reducing sugars, are shown by plotting their concentrations against corrections required. Flavonoids, represented by naringin, were not found to require increased corrections for increased concentrations above about 0.05%, probably due to low solubility, and no curve is shown for this constituent. The

combined effects of the constituents requiring negative corrections apparently amount to more than the sum of positive corrections required by citric acid and reducing sugars, at least in low-acid products such as orange juice or concentrate.

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CONSUMER OPINION OF SWEETENERS IN FROZEN CONCENTRATED LEMONADE AND ORANGE JUICE DRINK

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Three surveys were conducted among 320 families to determine consumer opinion of amount and type of sweetener in frozen, concentrated lemonade and in frozen, concentrated orange juice drink: Study 1—Determination of optimum sweetness in sucrose-sweetened concentrates. Study 2—Effect on acceptance of dextrose replacement of 10, 20, and 30% of the sucrose. Study 3—Effect on acceptance of corn syrup replacement of 10, 20, and 30% of the sucrose.

In the sucrose-sweetened pack, an optimum sweetness level of 11° Brix at a Brix-acid ratio of 16.0 was established for lemonade whereas 13° Brix at a Brix-acid ratio of 18.5 was optimum for the orange juice drink. A laboratory taste panel was utilized to establish equivalent sweetness levels between the variously sweetened concentrates.

122
WHEAT GLIADIN IN FOAMS FOR FOOD PRODUCTS

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Aqueous solutions of gliadin, the alcohol-soluble portion of wheat gluten, can be whipped into stable foams, bland in flavor and similar in some respects to those produced from egg white. Factors affecting the character and properties of gliadin foams were studied in connection with development of gliadin products suitable for use in foods. Two to 10% solutions of highly purified gliadins are easily converted to foams. The 3% solutions gave the maximum foam volume, amounting to a 25-fold increase. Variations in pH from 2.9 to 5.4 caused little change in volume or stability at room temperature, but salts can interfere by insolubilization of the gliadin. Sucrose enhanced stability, but decreased the volume obtainable. Cottonseed oil caused reduction in both volume and stability, whereas soy phosphatides reduced only the stability. When combined in low ratios with egg white some precipitation of the gliadin by natural salts in the egg was noted, but whipping properties were not affected adversely. Fifty per cent mixtures with egg-white produced foams equal in volume and room temperature stability to those made with egg alone. Whipping properties of the mixture in the presence of a small amount of yolk were also superior to those of egg whites alone. Preliminary results with gliadin partly deamidated to reduce sensitivity to salts were equal to those obtained with untreated gliadin.

123
MYOGLOBIN

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Myoglobin (Mb) is of considerable theoretical interest in connection with hemoprotein structure. The compound, which has been crystallized from the muscle tissue of a large number of animal species, is a relatively low molecular weight (17,000) protein consisting of a single polypeptide chain containing only one heme per mole. A three-dimensional model constructed with the aid of X-ray analyses (Kendrew *et al*, *Nature* **181**, 662, 1958) shows that Mb possesses a more complicated configuration than that provided by any theory of protein structure. The O_2 equilibrium of Mb is relatively uninfluenced by such factors as pH, ionic strength and urea concentration. Resynthesized proto-Mb appears to be identical with native Mb; deutero-Mb, however, exhibits a higher O_2 affinity (Rossi-Fanelli and Antonini, *Arch. Biochem. Biophys.*, **77**, 478, 1958). O'Hagan (Symp. Haematin Enzymes. Canberra, Aug. 31-Sept. 4, 1959) has suggested that a group in apomyoglobin binding the iron is a β or γ carboxyl rather than an imidazole group.

124
MILK PROTEINS

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Milk contains about 3.6% total protein, consisting of at least 15 different proteins. Our objective is to separate and characterize each of these proteins. Approximately 80% of the total protein is in the casein fraction obtained by acidifying milk, leaving the remaining 20% in the whey.

The methods developed for separating the casein fraction into its components involve pH, temperature, alcohol, urea, chromatography and ultracentrifugation. The proteins of whey have been separated largely by salt fractionation and dialysis.

Amino acid analyses of the individual proteins show wide variations in composition as well as similarities, revealing the nutritional value of each protein.

With the improvement of techniques, it has been shown that α-casein, the principal component of casein, is a mixture of at least 5 proteins. The separation, amino acid compositions and properties of several of the components of α-casein will be described.

125
PROPERTIES AND FOOD USES OF SOYBEAN PROTEIN

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The trend in research on soybean protein has been to study the crude protein fractions that arise in the commercial isolation of soybean protein. In the unmodified commercial procedure, defatted soybean meal is extracted with water or dilute alkali; the extract contains up to 90% of the nitrogen of which about 80% is precipitated by adjusting the pH to 4.5. The centrifugate from this acid-precipitated protein, often called the soybean whey solution, contains about 6% of the protein nitrogen and 4% nonprotein nitrogen. The ultracentrifuge patterns show at least 4 components for the acid-precipitated protein having sedimentation constants of approximately 2S, 7S, 11S, and 15S. When a concentrated aqueous extract of defatted meal is cooled, a cold-insoluble fraction is precipitated. This fraction is predominantly the 11S component. The acid-precipitated protein fraction contains 0.8–1.0% phosphorus which is present mostly as phytate and nucleic acids.

After partial separation by column chromatography, proteins of the whey fraction were found to contain a minimum of 13 components having sedimentation constants ranging from 1S to 6S. Some of the proteins identified in the whey fraction are two trypsin inhibitors, phosphatase, amylase, and a hemaglutinin.

Principal soybean food products now on the market include several types of soy flour, an enzyme modified protein, a concentrate containing about 70% protein, an acid-precipitated protein, and a sodium proteinate.

126
GEL ELECTROPHORESIS AND ITS APPLICATION TO ANALYSIS OF THE CASEINS

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Gel electrophoresis has been used to investigate the heterogeneity of many protein systems; Smithies (*Biochem. J.*, **71**, 585, 1959), in particular, has been able to resolve at least 14 components in human serum. When protein dispersing agents are added to the solvent phase, the method can be used to analyze mixtures of proteins where interactions between components make difficult the interpretation of results obtained by other physical methods. Possible applications and limitations of the present method of analysis will be discussed.

This technique has proved very useful in the analysis of the caseins. By moving boundary electrophoresis whole casein shows three fractions, usually labelled α, β and γ. Zone electrophoresis in concentrated urea, using both agar and starch gels as supporting media, shows the presence of considerably more than 3 components. The experimental methods which have been finally developed to give the most effective separation by both the agar and starch methods will be described. The relationship between the fractions previously obtained by moving boundary electrophoresis and those observed here will also be discussed, as well as a system for the nomenclature of these fractions.

127
THE EGG-WHITE PROTEINS. THEIR ROLES IN THE PROPERTIES OF EGGS AND EGG PRODUCTS

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Egg white is primarily a solution of proteins which have unique chemical and biochemical characteristics. Many of the egg-white proteins have been intensively studied because of

interest in their unique properties and because they are commonly used as "standards" in protein biochemistry. The egg-white proteins have also received attention for many years from immunochemists and quite recently from workers in comparative and genetic biochemistry. This is because there are so many different species and varieties in the avian class and because the different eggs may be obtained easily.

Eggs are a form of food commodity which is employed for direct consumption and also for the sake of the functional properties of the constitutent parts. The egg-white proteins have been found to be of major importance for three different properties. (1) The physical structure of the thick egg white is dependent upon the protein constituents. Changes or interactions involving the "ovomucin fractions" appear to be responsible for the deteriorative thinning of the egg white occurring during storage of shell eggs. (2) The proteins appear to be very important in the microbial defense mechanisms of the egg. Conalbumin, avidin, lysozyme, and possibly the ovomucoid and flavoprotein, may be involved. (3) The foaming, whipping and coagulating properties of egg white are all dependent on the proteins. Ovalbumin, the principal constituent, is of primary importance to these properties.

128
DAMAGE TO PROTEINS AND AMINO ACIDS BY IONIZING RADIATION

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The amino acids cysteine, cystine and methionine, the peptide glutathione, and a number of sulfyhydryl proteins were irradiated and analyzed for products of radiolysis, especially those containing sulfur.

For cysteine and cystine, the only volatile sulfur compound found was H_2S. For methionine, both CH_3SH and H_2S were found. Glutathione gave H_2S. Although sulfhydryl proteins were subjected to large amounts of irradiation and general radiolysis cleavage was observed, only traces of H_2S were found.

Formation of amides and carbonyls suggests that some radiolytic cleavage of proteins is at the peptide bonds.

129
ANTIBIOTIC RESIDUES AND KEEPING QUALITY OF PORK RESULTING FROM THE INTRAVENOUS ANTE-MORTEM INJECTION OF ACRONIZE CHLORTETRACYCLINE

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Pork is a highly perishable commodity which rapidly decreases in quality during long distance shipment. In order to study the effectiveness of Acronize chlortetracycline in retarding this spoilage, swine were injected in the anterior venacava with 4.6 mcg per g chlortetracycline. These were then held for different periods prior to slaughter. The antibiotic residues and keeping quality of various tissues were studied.

130
CHEMICAL CONTROL OF MICROBIAL SPOILAGE IN FRANKFURTERS

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Slime and mold spoilage, as well as greening problems, on frankfurters caused by microorganisms has long been a problem of the meat processor. Control of spoilage through sanitation and refrigeration, as commonly practiced by the industry, still leaves something to be desired. Returns, which can run high—particularly in the summer months—are indicative of this.

Studies to control spoilage using chemicals approved for use in food by the F.D.A. were conducted. Chemicals were applied at various concentrations as dips and sprays on inoculated and uninoculated frankfurters. The chemicals were also incorporated into the frankfurters in the formulating process.

Results indicate that greening, mold, and slime spoilage can be markedly reduced by the use of chemicals. The shelf life of frankfurters, as determined by visual inspection and microbial counts, has been increased by from one to three weeks depending on the initial contamination and the storage temperatures used.

131
PREPARATION AND STORAGE CHARACTERISTICS OF FREEZE-DRIED SAUSAGES. I. FORMULATION AND PROCESSING OF COMMINUTED SAUSAGES (FRANKFURTERS)

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This investigation was motivated by the "need for dehydrated sausage items which are ready to serve as soon as they are fully rehydrated." These items would be used in the Armed Forces quick-serve feeding systems, now in the test stage.

Freeze-drying of commercially finished products proved unsatisfactory. Also frankfurter batters taken from production lines in commercial plants suffered from fat rendering during freeze-drying and gave a rubbery texture upon rehydration. Investigations on the effect of (1) freezing rate, (2) composition of frankfurter batter, (3) degree of chopping, (4) thickness (in cm) of batter and (5) increased surface, on the behavior of the freeze-dried frankfurter batter during preparation, rehydration and on the characteristics of the rehydrated samples were carried out and are reported.

Several methods for rehydration are discussed. The following formula used in calculating per cent rehydration is introduced:

$$\% \text{ Rehydration} = \frac{W_R \times (100 - b) \times 100}{W_D \times (100 - a)}$$

Where: W_R = Weight of rehydrated sample
W_D = Weight of dry sample
a = % moisture in dry sample
b = % moisture in original sample.

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PREPARATION & STORAGE CHARACTERISTICS OF FREEZE-DRIED SAUSAGE. II. EMULSION STABILIZATION AND RATE OF FREEZE-DRYING IN COMMINUTED SAUSAGES (FRANKFURTERS)

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Several emulsifiers and stabilizers and combinations were utilized in the hope of minimizing fat-separation during processing and rehydration of freeze-dried frankfurters. The hydrophylic-lipophylic balance of the frankfurter emulsion was determined. The efficiency of such materials in frankfurter-emulsion stabilization is discussed. The discussion also includes their effect on freeze-drying rates of the frankfurter batters. An increase in the freeze-drying time is apparently the price of minimizing fat-separation in such emulsions.

Suggested criteria for judging the use of an emulsifier or stabilizer in preparing freeze-dried frankfurter batters include:

1. Degree of minimizing fat-separation.
2. Ease of dehydration of the batters.
3. Effect on rehydration.
4. Effect on the organoleptic properties of the frankfurters after rehydration.

133
AN ACCELERATED OXIDATION METHOD FOR THE ESTIMATION OF THE STORAGE LIFE OF FROZEN SEAFOODS

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The autoxidation of the fat in frozen seafoods may be used as a test of quality. The method described in this report promotes the acceleration of the oxidation reaction in frozen seafoods, the extent of which is determined by the 2-thiobarbituric acid procedure. This is accomplished by blending the ground, frozen sample with a purified diatomaceous earth thereby greatly increasing the surface area and allowing the oxidation to proceed at an accelerated rate. The effect of temperature, metal ions, antioxidants and packaging materials upon the rate of reaction are discussed. Preliminary investigations indicate that this accelerated oxidation method is also applicable to fats and oils.

134
THE PREVENTION OF BLUE DISCOLORATION OF CANNED CRAB MEAT BY FRACTIONAL COAGULATION AND LOW TEMPERATURE COOKING METHODS

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The causes of blue discoloration in canned crab meat and its prevention have been studied by many investigators in the past 60 years. However, no definitive conclusion has been made as to the cause and prevention of blue discoloration.

The principle, theory, and practical preventive method of blue discoloration of canned crab meat by the fractional coagulation and low temperature cooking are as follows.

1) There are differences in thermal coagulation point (TCP) between hemocyanin and muscles of crab.
2) The hemocyanin can be separated from the crab meat muscles by the difference in their TCP.
3) The crab meat is cooked at a temperature which is lower than the TCP of hemocyanin (about 70° C) but higher than the TCP of muscle (43–65° C). The meat is then removed from its shell and the hemocyanin which is in its liquid state, is removed by washing with water.

Based upon the process involving the principle and theory of TCP, the hemocyanin can be eliminated very easily and the blue discoloration of canned crab meat avoided.

The chemical and physical data obtained from this study will be presented. Also, the method of preparation of boneless crab meat for canning and frozen pack using fractional coagulation and low-temperature cooking will be mentioned.

135
FORMATION OF ACETOIN IN COD FILLETS DURING REFRIGERATED STORAGE

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The formation of neutral carbonyls in stored cod fillets was studied as a part of a survey of the chemical compounds that are formed in fish as a result of bacterial spoilage.

Fillets obtained from a commercial source were stored for various periods at 34 ± 2° F. Paper chromatographic analysis of the fillet extracts showed that acetoin was the main neutral carbonyl formed. The acetoin content of the fillets, which was determined as the 2,4-dinitrophenylhydrazone derivative in alkali, increased from less than 1 mg to values as great as 11 mg per 100 g. When the odor of the fillet was used as the criterion for acceptability, the rise in acetoin content was found to occur at about the time when the fillet was judged unacceptable. In the advanced stages of deterioration, the content of acetoin decreased.

The application of the quantitative test for acetoin as a measure of the quality of cod fillets will be discussed.

136
STUDIES ON THE ESTIMATION OF THE STORAGE LIFE OF RAW FISHERY PRODUCTS

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Estimating the future storage life of raw fish samples at various temperatures is often quite difficult and uncertain. Sensory, bacteriological and chemical examination before and after incubation periods of 2 to 7 hours at 31° C have been carried out in an attempt to accelerate spoilage and thereby obtain an estimate of the potential keeping quality. Material used included, among others, sole, rockfish, salmon, crab and shrimp. It was found that really fresh samples showed no or little change after an incubation period, in contrast to fish at various stages of freshness which showed definite changes after incubation. The data obtained so far indicate that the high temperature storage for a short time offers a useful means of evaluating the freshness of a sample and its shelf-life.

137
STANDARDIZED COLOR MEASUREMENTS OF FOOD PRODUCTS

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Color measurements normally apply either to flat opaque surfaces, or to transparent volumes. Many food products measured for color are neither transparent nor do they possess opaque surfaces. When measured for color as opaque surfaces, precautions have to be taken to assure representative and repeatable values of color.

The chief source of discrepancy between instruments used for colors of food products is light, which penetrates the specimen to a depth that is an appreciable fraction of the diameter exposed. Some of this light travels laterally within the specimen and is trapped behind the edge of the viewing window when it attempts to emerge. Wavelengths having the same hue as the specimen are least likely to be absorbed by the specimen dyes and pigments, and therefore are most likely to travel far enough to be trapped by small windows. Thus, color instruments with small windows tend to measure food specimens as darker and less saturated (grayer) in color than do large-window instruments.

For example, with one-inch illuminated area, a change in diameter of the viewing window from 2 to 1¼ inches changed the L, a and b Color Difference Meter readings of a specimen of tomato juice from 28.4, 25.8 and 13.2 to 26.9, 22.8 and 12.5. Since the light which is trapped in the instrument situation is seen in the everyday viewing situation, the small-window instruments must be said to give non-representative values of color. A 2-inch diameter window and 1-inch illuminated area are large enough to provide uniform, representative values of color of some food products and for most a 4-inch window is adequate.

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NONDESTRUCTIVE MEASUREMENT OF QUALITY FACTORS BY LIGHT TRANSMITTANCE

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Many important quality factors can be indicated by compositional analysis of the contents. Spectrophotometry offers the possiblity of making this analysis without destroying the sample. The requirements for spectrophotometry of intact fruits and vegetables are discussed. The types of special instruments required for these measurements are described. These include two-filter photometers and rceording spectrophotometers sensitive enough for light-transmittance measurements on samples such as intact peaches and apples. The principles necessary for making these measurements on an automatic machine are discussed and it is shown that high speed sorting by light transmittance is possible. Results are given for the measurement of chlorophyll content of apples, internal color of tomatoes, maturity of plums, smut content of wheat, and the detection of hollowheart in potatoes. The possibilities of this type of measurement for other quality factors are explored, and many possible applications are suggested.

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FOOD TEXTURAL MEASURING INSTRUMENTS AND THEIR STANDARDIZATION AND CALIBRATION

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Textural (kinesthetic) characteristics of food deal with those quality factors which the consumer experiences through his sense of feel, particularly mouth-feel. Textural measuring instruments, as used here, are physical measuring systems which simulate these sensations of the consumer and have in common the principle of resistance to force. Thus, the unit of measurement may be in terms of pounds force derived from one or a combination of two or more of the following principles: compression, shearing, cutting, and tensile strength.

In addition to accuracy and precision, such instruments should possess the ability to be easily standardized and calibrated. It is important for individual units of the same instrument to give comparable values. It is also amiable for these values to be easily related to absolute terms such as pounds force by a standard calibrating procedure.

Several attempts have been made towards finding satisfactory methods for standardization of such shear and compression instruments. One method would be by the use of some stable material which would show a constant resistance to a given force. As yet, no such material is available. Relating instrument values to recognized chemical tests of a textural attribute has proven too time consuming. A more satisfactory procedure has been incorporated into the design of the Shearpress, based on the use of proving rings as used by the National Bureau of Standards for calibrating testing machines.

140
USE OF GAS CHROMATOGRAPHY IN FLAVOR QUALITY CONTROL

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A short discussion of the principles of gas chromatography and the diversity of instrumentation available will be presented. This will include discussion of columnar materials, temperature control, types of detectors, and their limits of sensitivity.

Examples will be given of how this technique can be advantageously used in Quality Control in such industries as dairy, baking, confectionery, fats and oils, flavorings, non-alcoholic and alcoholic beverages.

141
AUTOMATIC CONTROL OF A ROTARY PISTON FILLING MACHINE BY A NUCLEAR FILL LEVEL MEASURING SYSTEM

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Conventional periodic sampling techniques used to control filling machines are often statistically inadequate.

To permit improved control, the entire output of a machine is gauged by a continuous fill level measuring system. This is accomplished in commercial operation using nuclear radiation measurement techniques. Filled containers are conveyed between a radiaton source and a detector. The amount of radiation received by the detector is related to the average fill level. The signal developed by the radiation measurement circuit is read out on indicators or recorders. An automatic controller increases or decreases container fill by energizing a motor coupled to the machine adjustment mechanism. The improvement in fill control is measured by statistical comparison of individual can fill data before and after the application of the automatic control system. Reduction in range of fill distribution results in better conformity to fill standards. Economic benefits made possible by the reduction in overfill are derived from the comparative data.

142
STANDARDIZATION OF COFFEE COLOR MEASUREMENT

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In the coffee industry the evaluation of roast color has always played an important role in manufacturing. It has been assumed that it is associated with flavor development. Color measurement, either visually or instrumentally, has been used to determine when a roasting operation should be terminated and to maintain color control, therefore, flavor uniformity, on the operation. A variety of names for different degrees of roast is prevalent as well as a variety of systems based on numbers derived from instrumental measurement. No national agreement on descriptive terminology or on numerical systems is available. This paper will present descriptive terminology and suggest a numerical approach based on reflectance that can be used for standardizing color measurement, developing quality control, coordinating investigations on roasting operations and correlating cumulated information.

143
OPTIMUM SAMPLING PROCEDURES FOR RAW PRODUCTS

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Efficient sampling procedures for raw products may be developed for given statistical precision and costs of sampling and grading. Application of the subsampling technique is appropriate for most raw product sampling problems in deriving optimum procedures.

Raw products in loads as received by processors may be classified into various units—pallets, boxes, etc. Components of variance for these units obtained from analysis of variance are the basis for estimates of variance of variables. Flexibility is the principal advantage of sub- or multistage-sampling as compared to one-stage sampling. It enables derivation of the optimum procedure, given required statistical precision and/or cost standards.

Sub-sampling of tomato loads is reported for the variables pH and solids. The development of optimum sampling procedures is demonstrated for estimated components of variance and sampling costs. Sub-sampling in estimating attributes, per cent cannable fruit, is also reported.

144
A GRAPHIC SEQUENTIAL SAMPLING PROCEDURE FOR MOLD COUNT DETERMINATION

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The Howard method determines trace contamination in comminuted products by a count of the microscopic fields which contain mold filaments out of 25, 50 or more examined fields. Products with Howard counts exceeding certain limits are not acceptable. Mold counts by the official method are time consuming and under some conditions the risk of packing a product which exceeds the limiting count is slight. A modification is therefore suggested to reduce the sampling rate (i.e., the number of fields examined per sample) when the counts are low, and to increase the sampling rate when the limiting contamination is approached. This is done by examining sets of 10 fields in sequence, deciding after each set whether the count is low enough to discontinue. A printed form facilitates the procedure.

The risk of an erroneous conclusion varies inversely with the sample size. Since Howard mold counts follow a binomial distribution the risk can be calculated for a given sample size. Confidence levels for the suggested procedure have been selected to vary with the number of fields examined.

The modification is expected to save time compared to the official procedure whenever the actual mold content is less than roughly half of the limiting quantity.

145
STATISTICAL QUALITY CONTROL TECHNIQUES IN CANNING PLANTS

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The use of Statistical Quality Control in canning plants has required the modification of some of the more classical techniques so as to better fill the needs. Several simple modifications of X Bar R Charts can be used to control attributes such as fill weights. C Charts may be useful for controlling defects by regulating the flow of raw product over sorting belts. Statistical techniques need not be too elaborate to be of practical use within the canning plant.

146
QUICK RANK TESTS FOR DETERMINING STATISTICALLY SIGNIFICANT DIFFERENCES

AMIHUD KRAMER
University of Maryland
College Park, Maryland

A statistical procedure is presented where treatments (samples) are arranged in rank order, the ranks summed, and the statistical significance for a given treatment determined by reference to tables. Examples are presented for determining significance of one treatment selected in advance, as in the case of comparing one's product against competitive products; comparing all treatments; determining significance of interactions, such as between judges and treatments in a taste panel; and sequential applications that may be used in evolutionary operations.

147
COLOR AND ENZYME INACTIVATION OF PROCESSED PEAS

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The stabilization of peas at a high temperature, short time process (HTST) has shown much promise in retaining color and flavor of peas. Recent work has indicated it requires a more severe process to inactivate the enzymes than to sterilize peas using an HTST process. Peroxidase activity and color measurements were carried out from samples of peas processed from 230° F to 280° F at various times over a 4 weeks' storage period. The lethality required to inactivate the enzyme at 280° F was tenfold higher than that at 250° F. Color was found to be better at high process levels for the first 2 weeks of storage, but at the end of 4 weeks all retort temperatures had about the same color. It may be possible to sterilize the peas at high temperatures than inactivate the enzymes at low temperatures for a longer time.

148
DEGRADATION OF CHLOROPHYLL DERIVATIVES IN ACID SOLUTIONS

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The reaction rates of the initial phase of the forward reaction of the acid catalysed conversion of chlorophyll a and b to pheophytin a and b, and several chlorophyllides to their respective pheophorbides were studied at various concentrations of hydrochloric acid and pigment.

The rate constants were determined spectrophotometrically at 25, 35 and 45° C. The energies of activation (Δ Ha) were determined for the chlorophylls and their derivatives from the above data.

149
EFFECT OF IODIZED SALT ON THE DETINNING OF CANS BY GREEN BEANS

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The problem of internal container detinning by green beans is an industry problem for which there is no immediate satis-

factory solution. Many diverse experimental studies have been made in the search for an answer to the problem. In one approach, unexpected results were noted in two lots of 1.25 plain body cans packed with green beans differing only in the type salt used—iodized salt in one lot and standard salt in the other. Nearly a 100% extension of service life at 100° F was noted in the iodized salt lot. Later studies established that the sodium thiosulfate stabilizer portion of the iodized salt was the ingredient effecting the reduction in internal container detinning. Results of additional experimental packs of green beans confirm earlier evidence that the use of iodized salt, when sodium thiosulfate is used as the stabilizer, effects a reduction in internal can detinning and an increase in service life.

150
OPTICAL DENSITY OF TOMATO CONCENTRATES AS A MEASURE OF HEAT INDUCED CHANGES IN PRODUCT CORROSIVITY

HARLEY H. HERNANDEZ and JAMES F. FEASTER
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San Francisco, California

Methods of evaluation of heat induced changes in tomato concentrates are discussed, and a method is presented which can be used for both quality determination and estimation of shelf life.

The analytical procedure involves the determination of optical density of tomato serum at 420 mmc. The serum is obtained by centrifuging after dilution to 2½% tomato solids, clarifying with pectinase, and filtration with the aid of diatomaceous silica.

Curves are presented which show the relationship of tomato solids, heat damage, and storage temperature on shelf life. The effect of storage temperature on product is also discussed.

Applications of the method are presented.

151
EFFECT OF PACKAGING FILMS AND STORAGE TEMPERATURES ON THE RIPENING OF MATURE GREEN TOMATOES

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Exploratory studies were conducted to determine the effect of several packaging wraps on the storage life of mature-green tomatoes stored at 5°, 10°, 15°, 20° and 25° C and at ambient room temperature. Tomatoes stored at 5° C did not ripen normally; apparently this temperature was subminimal and predisposed the fruit to decay. At the other temperatures used, ripening proceeded in the following order: ambient room >25°>20°>15°>10° C. Tomatoes kept satisfactorily for 2½ months at 10° C and for 2 months at 15° C, while most of the produce spoiled in less than 1½ months at 20° C. Storage for longer than one month at ambient temperature or at 25° C was exceptional.

Judging panels considered tray-packed tomatoes overwrapped with cellulose acetate (CA) more attractive than unwrapped tomatoes or those fruits packaged in polystyrene (Q641.4), polyethylene, LSAD cellophane, Pliofilm, polyvinylchloride (Saran) and Cryovac. CA had good transparency, adequate mechanical strength and sufficient permeability to gases and water vapor transmission so that there was adequate ventilation and yet the package did not fog or become inflated. However, this film permitted greatest shrinkage. There was some fogging in all of the other films but this defect was less pronounced in Q641.4 than in the more impermeable types such as polyethylene, Pliofilm, Saran and Cryovac. During the early part of the storage period, polyethylene overwraps were distended; later, after oxygen and carbon dioxide had migrated through the film, respiration demand caused reduced partial pressure within the tray: Tomatoes did not ripen normally when packaged in polyethylene. Weight losses were minimal in trays wrapped in Pliofilm, Saran and Cryovac but the fruit decayed and the trays became water-logged.

152
EFFECT OF SODIUM CHLORIDE, CITRIC ACID AND SUCROSE ON pH AND PALATABILITY OF CANNED TOMATOES

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Selected lots of California tomatoes with pH values ranging from 4.4 to 4.8 were acidified with citric acid to lower the pH and to facilitate heat sterilization. Varying amounts of sodium chloride and sucrose were also added to improve flavor acceptance of the canned product. Two days and 3 months, respectively, after canning, the samples were analyzed for pH, acidity, soluble solids, and drained weight. A panel of 14 persons evaluated the flavor of the samples by the balanced incomplete block method. In the 5 varieties of tomatoes tested, addition of citric acid alone impaired palatability while a combination of sucrose and citric acid improved it. The relationship between the buffer capacity and pH, and the advantages of proper adjustment of the sugar/acid ratio in canned whole tomatoes are discussed.

153
EFFECT OF HARVEST MATURITY ON CONSISTENCY OF CANNED TOMATO JUICE

B. S. LUH, FIDEL VILLARREAL, S. J. LEONARD, and M. YAMAGUCHI
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University of California
Davis, California

Tomato juices were canned during the early, middle, and late seasons at 4 different stages of ripeness, as judged by skin color and the Agtron E colorimeter. The effect of harvest maturity on pectin, cellulose, and consistency of canned juices was investigated.

Total pectin decreased considerably with maturation. Protopectin decreased in proportion to an increase in water-soluble pectin, indicating solubilization of protopectin as the fruit matured. Pear-shaped tomato varieties contained higher pectin than round-shaped varieties. The varietal characteristics of resistance to Fusarium and Verticillium wilt appeared to be independent of pectin content. Within the maturity range used in this investigation, the cellulose content of the tomatoes remained practically constant. The Brookfield viscosimeter and the pipete methods were used to determine consistency. A decrease in juice consistency accompanied maturation, presumably because of the transformation of protopectin into water-soluble pectin. At comparable ripeness levels, juices canned from early season tomatoes were lower in consistency than those of the middle and late seasons. The consistency of the tomato juice was lowered when the pulp was depectinized with versene (ethylene diamine tetra acetate) and then recombined with the serum. This indicated that pectic substances in the tomato pulp is an important contributor to juice consistency. Various factors influencing consistency of tomato juice are discussed.

154
FACTORS INFLUENCING pH VALUES OF PROCESSED TOMATOES

HAROLD W. ADAMS
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The pH value of raw tomatoes in California appears to be increasing over the past few years. A program was initiated to determine the minimum and maximum pH values of tomatoes from the raw stage to the finished product. The effects of lye peeling and steam peeling tomatoes were studied. The use of citric acid on peeled tomatoes was investigated. Correlation of total solids versus pH values was also determined. Sodium analyses were obtained on tomatoes at various stages of processing.

155
LOW TEMPERATURE HANDLING OF STERILIZED FOODS. II. THE STORAGE STABILITY OF THE COLOR OF HIGH TEMPERATURE SHORT TIME STERILIZED GREEN PEAS

A. I. EPSTEIN, E. F. STIER, and C. OLIN BALL
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New Brunswick, New Jersey

The thermal destruction of green pea color during processing was studied. The thermal destruction of green color of peas was found to follow first-order kinetics. The kinetics described by this reaction were found to be in agreement with the kinetics developed by other workers.

Loss in residual color left in thermal processed peas processed at 265° F, 285° F, and 300° F was studied at four storage temperatures 85° F, 50° F, 35° F, and −25° F. The loss of green color in storage follows first-order kinetics. No difference in reaction rates were found for the loss of color in storage between peas given equivalent processes at different temperatures and stored at the same temperature.

The effect of added acidity on the loss of green color during storage was also studied. The added acidity hastened the loss of color during storage at 85° F.

156
LOW TEMPERATURE HANDLING OF STERILIZED FOODS. IV. THE EFFECTS OF STORAGE TEMPERATURE ON THE QUALITY OF FROZEN AND OF HTST AND CONVENTIONALLY STERILIZED CANNED VEGETABLES, SOUP, AND EVAPORATED MILK

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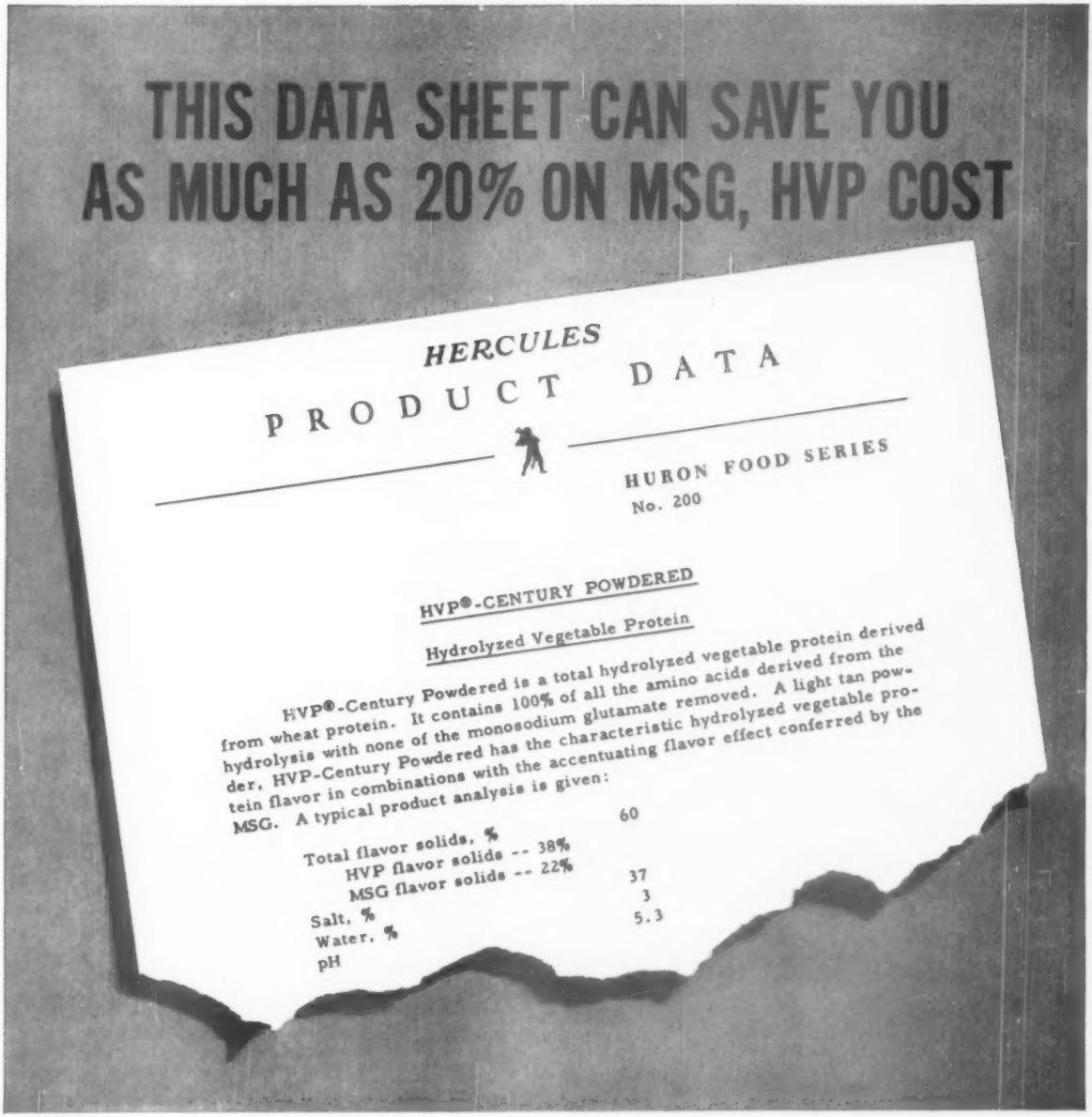
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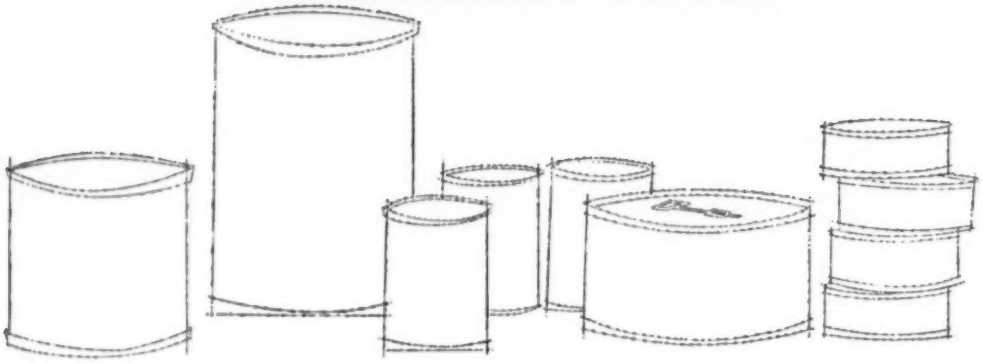

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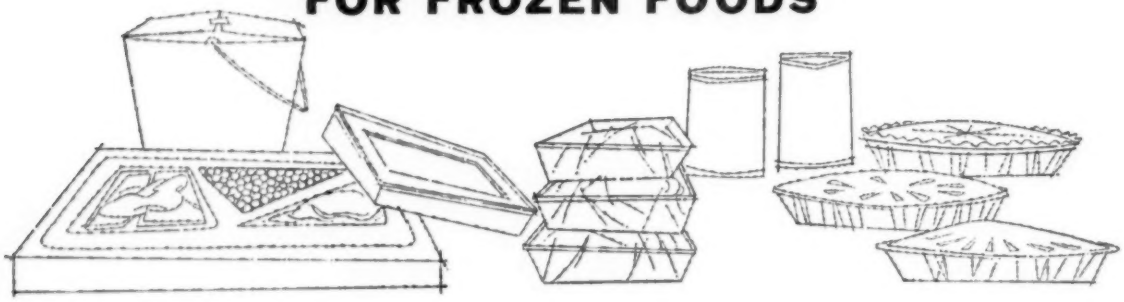

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A. I. EPSTEIN, G. J. LAURO, E. F. STIER, and C. OLIN BALL
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Seven canned products—tomato juice, cream style corn, green peas, oyster stew soup, vegetable with beef soup, pea with ham soup and evaporated milk—have been packed by both HTST and conventional methods. Of each product, about 11% of the material, sealed in cans, was frozen and stored at 0° F. Approximately the same quantity of each product, processed by each of the two methods of sterilization were stored at 85° F, 50° F, 35° F and 25° F. A measure of the initial flavor and color of each of the products was made. The cream style corn and green pea samples have been evaluated after 3, 6, and 12 months in storage; the tomato juice, vegetable with beef soup, pea with ham soup and the evaporated milk samples have been evaluated after 3, 6, 12 and 18 months in storage; the oyster stew soup samples have been evaluated after 3, 6, 12 and 24 months in storage.

The effect of processing by either HTST or conventional techniques, length of time in storage and storage temperature on the flavor and color of the products are discussed.

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INFLUENCE OF FREEZING AND THAWING AND FREEZE DEHYDRATION ON THE HYDRATION AND CHARGES OF MEAT PROTEINS

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This study was undertaken to define more clearly the undesirable water-holding characteristics of some freeze dehydrated meat. Quick-freezing and thawing of beef result in no considerable denaturation of muscle protein. Quick-freezing causes a very small but significant increase of the water-holding capacity of meat, probably by a mechanical loosening of tissue-structure due to the formation of tiny ice crystals inside the cells. Slow-freezing causes a significantly small decrease of the water-holding capacity of meat, probably due to some destruction of protein structure by formation of large ice crystals between the cells.

Freeze-drying of beef results in a drop in water-holding capacity only in the isoelectric pH-range of muscle. It causes a tighter network of protein structure, probably because the peptide chains after drying lie more closely together. The tighter structure may be stabilized by the formation of new salt and/or hydrogen bonds. Freeze-drying causes an increase of basic and acidic groups of proteins in the basic but not in the acidic range of the isoelectric point. This increase is probably due to a cleavage of metallic cross linkages between the protein chains. The undesirable changes in meat during freeze-drying are not attributable to the freezing process itself. Furthermore, these changes are not identical with the alteration of meat by heat denaturation.

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EMULSION FORMATION IN FINELY COMMINUTED SAUSAGE

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A dispersion of fat globules is formed within a protein slurry during chopping of finely comminuted sausage. The comparatively soft fat is broken up early in the comminution process. Muscle fibers of meat have a stronger structure than fat and are the component which determines the total chopping required. The fragments of tough connective tissue formed by preliminary grinding appear to remain unchanged during chopping of sausage emulsions.

Total chopping time must be sufficient to form a protein matrix enclosing the dispersed fat globules. The salt-soluble proteins, myosin and actomyosin, lower the interfacial tension and form a concentrated membrane on the fat globule surface.

If excessive temperature rise occurs during chopping, the protein matrix may be partially denatured and broken giving rise to an unprotected fat dispersion. This permits fat separation during smoking and cooking. These observations are illustrated with photomicrographs.

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DETERMINATION OF MEAT SWELLING AS A METHOD FOR INVESTIGATING THE WATER-BINDING CAPACITY OF MUSCLE PROTEINS WITH LOW WATER-HOLDING FORCES

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Meat tissue immersed in water or an aqueous solution takes up the water under the influence of electrostatic forces of muscle proteins with a simultaneous loosening of the protein structure. This process is called meat swelling. In order to facilitate this process the muscle tissue (beef and pork meat) was disintegrated (Waring blender) in the presence of water and the swollen muscle tissue separated by centrifugation. Under favorable conditions (pH 6.5–7.0; ionic strength 0.5–1.0) 3 parts of water were absorbed by one part meat, resulting in so-called "maximal meat swelling."

A method for the determination of the meat swelling will be presented and its application in the investigation of various experimental conditions (degree of meat disintegration, time and force of centrifugation, temperature of blending, etc.) and various meat additives (pH-modifiers, chloride salts of Na, K, Mg, and Ca). Meat swelling, as determined by this method in relation to various meat additives, varied within a much wider range than the water-holding capacity of the same meat samples, while using the other methods for the determination of water-binding properties of meats (*J. Agr. Food Chem.*, 6, 387, 1958; *Food Technol.*, 11, 69, 1957).

It is postulated that the swelling of meat occurs stepwise by adding new layers of the bound water to the already existing layers of the bound water around muscle protein molecules with the water-holding forces decreasing with increasing the distance between the water layers and the protein molecules. The existence of different layers of the bound water has been proved by a stepwise release of water from the swollen meat by the application of different pressure and/or different temperature of the heat denaturation of the meat. The theory of hydration of muscle proteins, involving the existence of multilayers of the water of hydration, will be discussed.

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TENDERED MEAT THROUGH ANTEMORTEM VASCULAR INJECTION OF PROTEOLYTIC ENZYMES

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Tenderness is the most desired eating quality in cooked meats. Selection, processing, and cooking have been the accepted methods to date for developing tenderness. This paper presents a new approach to meat tenderization, the injection of a proteolytic enzyme into the vascular system of the live animal. This technique provides distribution of enzyme to the capillary bed of all of the meat tissue. The process has been given U. S. Patent No. 2,903,362 and has been approved by the Meat Inspection Division of the U. S. Department of Agriculture. Tenderization of the meat due to the activity of the enzyme occurs during the cooking of the meat. Aging is not required. Meat may be shipped immediately following chill and is ready for retail consumption within the three or four day period for normal distribution from the processor to the consumer. This allows normal marketing distribution of carcasses and cuts from beef processed in this manner. An added feature of this method of tenderization is the fact that it can be used on all grades of meat and that the normally less tender cuts such as chuck, rounds, briskets and plates can be dry heat roasted to provide tender cooked meat servings.

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TENDERNESS AND CHEMICAL COMPOSITION OF BEEF. I. VARIATIONS AMONG ANIMALS TREATED ALIKE

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The amount of variation between meat cuts from animals of similar breeding and management is of importance in designing experiments. Samples were tested from 4 groups of animals, with 8 animals in each group. The 4 treatment groups were (1) fed to Good grade, (2) fed to Choice grade, (3) stilbestrol implanted, fed to Choice grade, and (4) stilbestrol in the feed, fed to Choice grade.

The *semitendinosus* muscles were obtained from the right and left sides of each carcass. Each muscle was divided into 3 parts, one being analyzed raw, one cooked to the rare stage, and one to the well done stage. Information on cooking losses was obtained for each roast. The cooked meat was evaluated for tenderness by panel scoring, number of chews, and Warner-Bratzler Shear. Analyses were made for moisture, fat, total nitrogen, and amount of collagen and elastin. The data will be discussed in terms of variation between parts of the same muscle, between

right and left sides of the same animal, and among the several animals of similar breeding and management within each group.

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VARIATIONS AND THEIR CAUSES IN THE MEASUREMENT OF BEEF TENDERNESS BY THE ELECTRIC GRINDER METHOD

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Bayonne, New Jersey
and
Department of Food Science, Rutgers, The State University
New Brunswick, New Jersey

A method of determining a measurement of tenderness of beef rounds by using the meat grinder attachment to an elecrtic mixer (Hobart Model N 50) was investigated. Voltage, amperage, and power consumption were measured under no load and load conditions. The effect of friction, wear and assembly of grinder parts and cleanliness of parts on power consumption were investigated. It was found that variations can be decreased by maintaining constant voltage, stabilizing resistance by grinder warm-up period and by replicating no load and load readings and using averages. The use of an automatic timer to turn power on and off is indicated to further reduce variation. By measuring the difference between no load and load (50 g beef) power consumption (to .0067 watt hour) per unit time it was found that the electric grinder method can be used as a measurement for the tenderness of beef. There was, however, lack of good correlation between this method and the Warner-Bratzler Shear, orifice and taste panel methods of measuring tenderness.

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BIOCHEMICAL FACTORS AFFECTING BEEF TENDERNESS

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and
University of Missouri
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The purpose of this investigation was to study the factors associated with differences in the tenderness of beef. The effect of beef muscle components on tenderness was studied during low and high temperature aging periods on carcasses which differed in chronological age and degree of ante-mortem stress. Samples were taken from the *Longissimus dorsi* muscle for the analysis of extractable Na, K, Ca, Mg, N and PO_4 at various intervals during aging. A trained laboratory panel and the Warner-Bratzler Shear were used to evaluate tenderness.

Tenderness improved during aging and was found to be associated with changes in pH, water-holding capacity and water-extractable nitrogen and mineral ions. The water-holding capacity of the muscle was affected by the changes in pH during aging. Tenderness was not directly related to the individual components but the interrelationships and transfers of these components in association with the meat proteins produced and increased tenderization during aging.

Magnesium was the only mineral component present in the expelled juice of the water-holding capacity determination that appeared to be related to tenderness. The pH of cooked meat increased while the pH of the expelled juice decreased when cooked in the water-holding capacity tubes. The protein alterations which occurred during the cooking process apparently eliminated any gross differences in texture due to the pH of the raw meat.

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A COMPARISON OF OBJECTIVE PHYSICAL MEASUREMENTS TO DETERMINE MEAT TENDERNESS

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and J. L. MCBEE, JR.
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Identification of tenderness is a primary deterrent to consumer oriented quality control progams in the meat industry. The purpose of these studies was to determine the relationship between several objective measures of tenderness and subjective tenderness evaluation.

Mechanical tenderness evaluations of raw and cooked beef were compared with tenderness evaluation by a 240-member consumer panel and a 6-member trained sensory panel. The study included evaluation of samples from more than 650 cattle grading from Utility to Choice. The bulk of the studies, however, was confined to the Good and Choice grades. Raw and cooked samples from the *Longissimus dorsi* of each cattle were evaluated with an adaptation of the Sperring tenderness press and the Warner-Bratzler Shear. One-inch core samples were used on both instruments and biopsy sized samples on the tenderness press. The tenderness press was adapted for use with a LEE-Kramer press.

Significant relationships were found between sensory evaluation and the mechanical methods. The magnitude of the relationships varied with sampling techniques, mechanical devices and grades of beef.

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THE TENDERIZATION PATTERN IN ADRENALINE-TREATED POULTRY

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Previous work from this laboratory has indicated that, in the normal course of rigor mortis and its resolution, an acceleration of the onset of rigor results in an increased toughness of the cooked meat. The post-mortem loss of adenosine triphosphate (ATP), the appearance of lactic acid (resulting from glycolysis), as well as the appearance of rigor have been studied in relation to tenderness.

For this study, lactic acid production from glycolysis has been prevented by the administration of sodium monobromoacetate, which inhibits glycolysis, or adrenaline, which causes the complete breakdown of glycogen in skeletal muscles of the live bird. An intravenous injection of sodium monobromoacetate (150 mg/kg) causes the death of the bird in 15–30 minutes. Biochemical examination of muscle from treated birds showed that (1) glycogen was not broken down post mortem, hence, little or no lactic acid was produced, and (2) ATP disappearance and the onset of rigor occurred rapidly. When adrenaline was injected subcutaneously 18 hours ante mortem (1 mg/kg), it caused almost complete breakdown of glycogen in skeletal muscle. Biochemical examination of muscle from the latter birds showed that (1) little or no glycogen was present at slaughter, hence, little or no lactic acid was produced, and (2) again, ATP disappearance and the onset of rigor occurred rapidly. Cooked muscle from birds subjected to either of these treatments was quite tender, even without aging. Evidently an accelerated rate of disappearance of ATP, which results in an increased rate of onset of rigor, is not necessarily followed by increased toughness. Hence, it would appear that lactic acid production or some other phase of glycolysis influences the tenderness pattern in poultry.

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CONSUMER ACCEPTABILITY OF BONELESS CARCASS BEEF

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Conventional beef cuts frequently contain muscle groups which differ grossly in eating characteristics. As a result, certain tender muscles contained in roasts fail to be utilized as steaks due to traditional cutting methods. This study was designed to identify those muscle groups which can be used to best advantage as steaks or roasts. Furthermore, it was desired to determine the extent that certain muscles can be used for both steaks and roasts.

Forty-five U. S. Good beef carcasses were fabricated into 6 boneless steak and roast groups and ground beef. The cut groups were oven and pot roasts; thick, thin, cube and swiss steaks. These cuts were evaluated by 258 consumer families.

All cut group-muscle origin combinations for oven and pot roasts, minute and swiss steaks were acceptable. There were significant differences in acceptability among muscle origins of thick and thin steaks. Consumer reaction indicated that some muscles customarily used as roasts are quite acceptable as steaks. Many muscle origins were acceptable for several cut groups, but might be better utilized for only one or two cut groups.

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RADIATION STERILIZATION OF FOOD. PART II. SOME ASPECTS OF GROWTH, SPORULATION AND THE RADIATION RESISTANCE OF SPORES OF *CLOSTRIDIUM BOTULINUM* TYPE E

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Although at present data are available in the literature upon the radiation resistance of spores of Type A and Type B *Cl. botulinum*, no published data are yet available on the radiation resistance of Type E spores. Type E *Clostridium botulinum* has appeared primarily as a contaminant of marine products and has been incriminated in a number of outbreaks of human botulism traceable to marine products in recent years. In the over-all survey of the radiation preservation of foods, marine products have received considerable attention from the aspects both of steriliza-

tion and the extension of refrigerated storage life. Data will be presented to show the comparative radiation resistance of spores of *Cl. botulinum*, Types A, B and E in a beef stew formulation used as the substrate. Growth, sporulation and toxin production from spore inocula of Type E cultures at 42–43° F and 48–50° F will be discussed. The possibility of outgrowth and toxin production in this temperature range from spores of Type E cultures surviving irradiation will be considered.

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EFFECT OF ELECTRON RADIATION ON SURVIVAL OF *BACILLUS STEAROTHERMOPHILUS* AT VARIOUS DEPTHS OF PENETRATION IN AGAR

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One of the drawbacks of the use of electrons from a high voltage accelerator for radiation preservation of foods has been limited depth penetration, thereby making the thickness of the food product an important factor for uniform dose distribution. In this study the dose received was measured by cobalt glass dosimetry and compared with the survival of spores of bacteria. Several different electron doses to the surface were used. Glass dosimeters and bacterial survival measurements were made at various depths with each different dose to the surface. Results were compared with those of a similar experiment using gamma rays from a spent fuel rod source calibrated by ferrous dosimetry. Measurement of the dose was achieved by placing cobalt glass dosimeters on the tops and bottoms of six 0.5 cm layers of 3.0% agar containing spores of *Bacillus stearothermophilus*. The layers were separated by and enclosed in heat-sealed pouches of Mylar-Saran-Polyethylene film.

A high degree of correlation between dose received and percent survival was observed at dose levels from 100,000 to 2 million rads. At lower doses or at agar depths greater than 1.5 cm results were more erratic. This relatively simple method of counting bacteria surviving in inoculated agar after irradiation might prove useful as a practical indicator of the uniformity of the dose received by foods to be processed with electrons.

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RADIORESISTANCE OF FIVE STRAINS OF *CLOSTRIDIUM BOTULINUM* IN SELECTED FOOD PRODUCTS

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Green beans, boned chicken, codfish, ground pork and beef were selected as media for ascertaining the gamma radioresistance of 5 strains of *Cl. botulinum*. The experimental program was designed to determine: (1) the effect of type of food product on the radio-resistance of each of five strains of *Cl. botulinum*, (2) the change in the relative radioresistances among 5 strains of *Cl. botulinum* attributable to the food substrate.

Five strains of Type A and 5 strains of Type B were surveyed to determine the particular strains of each type that manifested the highest and the lowest degree of radioresistance. The 4 strains so selected were used in this work. A non-toxic Type A strain, which exhibited a greater resistance than any of the others, was the fifth test organism in this program. Products were inoculated with approximately 1×10^8 spores per gram for each test strain. Dose levels used were, 0, .85 Mrads and 1.7 Mads with the product being held frozen prior, during and subsequent to irradiation.

Results based on survival counts indicated that the radioresistance of the test organisms is influenced by the product substrate in which they are irradiated, green beans giving the least protection against the radiation. This suggests that the minimum radiation dosages required for sterilization varies with the product. The order of relative radioresistance of the five strains was also observed to vary with food products.

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IRRADIATION RESISTANCE OF THE NATURAL BACTERIAL FLORA OF CURED HAM

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In order for a food process to be economically feasible in industry the level of spoilage must be extremely low. To preserve the nutritive properties of canned foods it would be desirable to use the minimum process schedule and still retain the necessary low level of spoilage, provided of course the process is adequate to destroy all potential food poisoning organisms.

This study was designed to determine the irradiation level necessary to destroy vegetative cells and spores normally present on cured ham. Three separate experiments were conducted using composite ham samples from many days production to give representative types of organisms. Both gamma and electron beam radiation sources were used. Eugon agar was used as the recovery media for anaerobic counts and TGYE agar for aerobic counts.

Results indicate that a higher level of radiation is needed to completely eliminate spores and vegetative cells than previously reported. Low levels of putrefactive anaerobic spores (several hundred per gram) are able to withstand over 5 million rad when irradiated in meat. The radiated spores do not appear to be able to germinate and produce spoilage in meat containing normal curing levels of salt and nitrite. However, when the spores were removed from the meat and subcultured in Eugon agar growth occurred.

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THE EFFECT OF ADDITIVES ON RADIATION-RESISTANCE OF *CLOSTRIDIUM BOTULINUM* IN MEAT

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Clostridium botulinum has been found to be the most irradiation resistant sporeformer tested. Certain food additives in the form of natural or artificial spices or salts may affect its irradiation resistance. The results being reported are the preliminary investigations on commonly used additives and their effects on two strains of *Cl. botulinum*. The fact that spices of various kinds and salts are used in the preparation of many types of specialty meat products makes it important to know whether these additives will have an effect on the dose levels required for sterilization. This information is essential before recommendations can be made on the level of irradiation required for sterilization.

Present indications are that sodium chloride and some spices, especially mustard (allyl isothiocyanate) when added in concentrations normally used in foods enhanced the lethal effect of irradiation while other spices had no effect, or actually increased the irradiation level required to sterilize.

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THE EFFECT OF BETA IRRADIATION AND CHLORTETRACYCLINE ON THE MICROBIAL FLORA OF FISH AND SHELLFISH

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Fillets of sole, rockfish and tuna, salmon steaks, crabmeat and shrimp were treated with various combinations of chlortetracycline, antioxidants and doses of beta radiation. During storage at 30° to 40° F the total bacterial numbers and type of flora were followed. The antibiotic and beta radiation treatments had different actions on the bacterial flora, resulting in a difference in the type of predominating organisms and spoilage. In general, the actions of the two types of treatment were complementary, resulting in an enhanced keeping quality over that from the individual treatments alone. Some studies on the radiation sensitivity of isolated organisms were also carried out. No markedly radiation resistant organisms were found.

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THE OBJECTIVES OF THE QUARTERMASTER FOOD AND CONTAINER INSTITUTE FOR THE ARMED FORCES RADIATION RESEARCH PROGRAM

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A contribution to the Radiation Preservation Symposium.

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DOSE REQUIREMENTS FOR THE RADIATION STERILIZATION OF FOODS

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Opening presentation in the panel discussion on radiation preservation.

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RADIATION PASTEURIZATION OF FOOD

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Second component of the panel discussion.

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BRITISH VIEWPOINT ON THE RADIATION PRESERVATION OF FOOD

M. INGRAM
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Cambridge, England

Final presentation of the panel discussion.

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SIMPLIFIED PROCEDURES FOR EVALUATING TASTE PANEL DATA

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Procedures designed to simplify the handling and evaluation of data derived from taste panel responses are presented and interpreted.

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THE EFFECT OF NUMBER OF JUDGMENTS IN A TEST ON FLAVOR EVALUATIONS FOR PREFERENCE

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Numerous sources in the literature indicate that discrimination or the ability to detect flavor differences decreases with an increasing number of samples. This is generally attributed to either psychological fatigue of the judge or to desensitivity of the taste buds. Work in our laboratory has made us question the universal validity of this assumption. This study was therefore designed to evaluate the effect of number of samples served in one test on the discrimination ability of the judge. For each of 4 products (hamburger, green beans, peaches, tomato juice), 20 samples having known flavor differences were assigned to 4 trays. Each tray always represented the same 5 samples. The order of the 4 trays of each product was assigned to the judges so as to have each tray tested in each possible order an equal number of times. For each product, each tray was judged in a given order by approximately 45 judges. The samples were scored on a nine-point hedonic scale. Analyses of variance were run for each tray and order on each product and the treatment mean square tested against the judge by treatment interaction to obtain an F ratio representing ability of the test to discriminate differences among the samples. The results on 3 of the 4 products indicate the judges had a lower ability to detect differences among the samples on the first tray than when the same samples were served on succeeding trays.

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SENSORY EVALUATION OF ACCESSORY FOODS WITH AND WITHOUT CARRIERS

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In sensory testing, work efficiency would be increased if foods that are ordinarily eaten not alone but served as accessories or condiments, such as mayonnaise, jelly or soy sauce, could be tested alone rather than in combination. Use of an appropriate carrier, such as, for the above, salad, bread, or chow mein, is more expensive and time consuming, requires assurance of the constancy of the carrier and may dilute out differences among the samples of a product. The question arises whether discrimination is adequate and whether results correspond by the two methods: (a) tested alone, and (b) tested with a normal "carrier" food. To answer these questions a series of experiments was conducted. In each experiment a number of treatments of an accessory food differing in quality were tested by the two methods. Testing was done in the laboratory using the single stimulus method. Groups of consumer subjects ($N = 36$) rated the products on the hedonic scale. In most cases, results were comparable for the two methods, or else serving alone improved discrimination. However, a few strong-flavored products, usually used in very small quantities, may require special consideration in sensory tesitng.

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MONOTONY CHARACTERISTICS OF FOODS

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How the number of different foods in a dietary and the type of menu planning affect food preferences and consumption was the focus of this study. Seventy-two soldier volunteers were randomly assigned to 3 experimental feeding conditions: (a) a pre-planned 3-day fixed menu cycle in which all meals came in the same sequence; (b) a pre-planned 6-day fixed cycle, using the same foods as in (a) plus and approximately equal number of new foods, and (3) a 3-day cycle using the same foods as in (a), but, after the first 3 days, allowing the men to devise their own menus. The foods were primarily canned and pre-cooked dehydrated. The 24 men in each treatment were divided into 4 six-man groups, in which food preparation and menu planning took place. After every meal, each subject completed a questionnaire on how much he ate and how he liked each food. The experiment continued for 24 days.

Results indicated that over-all loss of acceptability was slight, although there was a trend toward less satisfaction among the men under condition (b). Some foods increased in acceptability while others remained fairly stable. There was some evidence that preference ratings and consumption of a food depend upon the other foods served with it.

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ANALYSIS OF SOME COMMON INSECTICIDES BY GAS CHROMATOGRAPHY

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Gas chromatography offers a powerful tool in the study of isomeric forms and estimation of insecticide residues. It is also extremely useful for control of production, formulation and purification of pesticides.

The retention volumes and qualitative analysis of various chlorinated and organic-phosphorous insecticides were recently reported by Coulson *et al*. In this work a non-commercial unit employing glow plugs for the detector and Dow-Corning silicone grease for the packing was operated at 240° C. Coulson showed quantitative recoveries of lindane, parathion, aldrin and DDT. No decomposition was evident as determined by infrared spectroscopy.

At the 1959 Fall ACS meeting, G. Zweig and T. E. Archer presented an excellent study showing the separation and quantitative analysis of two Thiodan isomers. The Aerograph was used in this study with Dow silicone column at 250° C.

In the present study 10 common insecticides were analyzed separately with highly purified lindane added to each sample as an internal standard. This provided a comparison in retention times and area measurements. A table listing the retention time, area measurements, isomeric forms, and purity of each insecticide will be given.

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LOW-TEMPERATURE HANDLING OF STERILIZED FOODS. V. BIOCHEMICAL CHANGES IN STORAGE

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Changes in certain biochemical characteristics of sterilized foods stored for 12 months at 0° F, 35° F, 50° F, and 80° F were determined. The following high-temperature, short-time and conventional processed were studied: Tomato juice, green beans, whole kernel sweet corn; cream of potato, cream of shrimp and ham and pea soups, and oyster stew.

Changes in vitamins included thiamine in all products except ham and pea soup; riboflavin contents of corn and green beans; and ascorbic acid contents of all vegetables containing products. Color evaluations were made on each product by reflectance colorimetry, and on tomato juice by transmission colorimetry as well. Assays for acidity and alcohol insoluble solids were made on selected products. Changes in trimethylamine content were measured in the two shellfish products.

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TIME-TEMPERATURE TOLERANCE OF FROZEN FOODS. QUALITY CHANGES IN CAULIFLOWER

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Ten lots of cauliflower selected from commercial processing lines were exposed at 4 to 10 temperature conditions ranging from 40° to −20° F for periods of 1 day to 4 years. Reduced ascorbic acid content (AA) decreased logarithmically with time at constant temperatures, 0 to 40° F; the initial rate of loss about doubled for each 5° rise from 0 to 20° F. Cream, gray, and sometimes pink off-colors were noticeable within a year at 0° F. These colors also developed at higher temperatures initially, and then changed to light tan to brown on further exposure. A soluble color (Sol. C.) procedure was developed, where 40% acetone was used as an extractant, to measure increase in off-color with time. Visual color scores correlated with Sol. C. and reflectance color attributes. Industry acceptability scores were related to laboratory data to indicate a level of deterioration that may cause consumer complaint. Trained judges found that flavor differences were detectable within 1 day at 30°, 1 to 4 months at 10°, and about 1 year at 0° F when samples were compared with controls held at −20° F. Analytical data showed that considerable variation occurs among packages of a given lot and among lots. Such variation must be taken into account in the use of these measurements as quality standards.

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CHANGES IN SOYBEAN LIPIDS DURING THE TEMPEH FERMENTATION

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Changes in the lipids of soybeans brought about by the action of *Rhizopus oryzae* during the production of tempeh have been studied. The mold possesses strong lipase activity and caused the hydrolysis of over one-third of the neutral fat of the soybean during the three-day fermentation. The fatty acid composition of soybean tempeh was compared with that of cooked soybeans by means of vapor phase chromatography of the methyl esters. The neutral fat of the soybean was composed of palmitic, stearic, oleic, linoleic, and linolenic acids with linoleic acid predominating. These acids were liberated by the mold during the fermentation in roughly the same proportions as they occurred in the cooked soybeans. During the period of most active mold growth, between 24 and 30 hours, proportionately higher levels of palmitic acid were found, and the level of linoleic acid was somewhat lower. Except for the depletion of some 40% of the linolenic acid at the close of the fermentation there was apparently no preferential utilization of any particular fatty acid.

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INVESTIGATIONS OF THE EQUIVALENT WEIGHTS OF DEHYDRATED DICED POTATOES AND DEHYDRATED SLICED ONIONS IN COMPARISON TO THEIR FRESH COUNTERPARTS

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Published equivalent weight guides for dehydrated diced potatoes and dehydrated sliced onions were found to be varied and confusing with no reliable standards. Further, the Navy Recipe Service Cards which presently specify these two vegetables presently use a wide range of substitution ratios with no two alike. In this situation it was impossible to calculate any logistical comparisons: the comparisons differ with each recipe. Practical equivalent weight ratios for these two vegetables were determined by preparing representative recipes using various ratios and measuring the finished product yield and the acceptability of the product.

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VOLATILES CONTRIBUTING TO THE FLAVOR OF BARTLETT PEARS

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California Bartlett pears were stored at 32° F for varying periods of time, and ripened under controlled conditions. Batches of approximately 1200 pounds, selected for freedom from defects, were processed to purée as follows: washed and sorted whole pears were subjected to enzyme inactivation (ca 215° F), crushed, pulped, finished, deaerated, cooled and packaged in a totally enclosed system. The vapor produced in this enclosed system was removed by two water-cooled condensers in series, operating at 165–175° F and 70–75° F, respectively. The recovered essence possessed the typical desirable flavor and aroma of pears. Part of this material was used in add-back experiments to determine its effect on the flavor of the processed purée. Other portions of the essence were extracted with ethyl ether or ethyl chloride, dried over sodium sulfate, and the major part of the extracting solvent removed in a rotary evaporator. The concentrated extracts were examined by gas chromatography, and the influence of the various fractions on flavor was evaluated organoleptically.

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SEPARATION AND IDENTIFICATION OF COOKED BEEF FLAVOR COMPONENTS

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This investigation was undertaken to gain basic information concerning the chemical composition of volatile cooked beef flavor components. Volatile sulfides and carbonyl compounds from cooked beef were collected in a series of traps containing lead acetate and 2,4-dinitrophenylhydrazine solutions, respectively. Total cooked beef volatiles from a 1–3 meat-water dilution slurry were fractionated in liquid air traps and further fractionated and identified by the use of vapor phase chromatography and various qualitative tests. Three different chromatographic columns, dinonylphthalates, "Carbowax 400" and didececylphthalate, were employed during the course of this study. The presence of a black precipitate in the lead acetate trap was indicative of sulfides. Paper chromatographic analysis of the volatile carbonyls trapped as their 2,4-dinitrophenyl-hydrazone derivatives led to the identification of acetaldehyde. Two additional spots were observed on the chromatographic paper but were poorly resolved. Comparing retention volumes in the vapor fractometer of known compounds with those of the unknown volatiles, plus positive reactions to various qualitative tests, led to the tentative identification of carbon dioxide, methyl mercaptan, acetaldehyde, acetone, methyl sulfide and water as being present in the volatile mixture. The components fractionated in this study with the exception of water are believed to contribute to the flavor of cooked beef. The results obtained using paper and vapor phase chromatography would seem to indicate that perhaps additional compounds are also involved. Such additional compounds, even though present in small quantities, could conceivably contribute to cooked beef flavor.

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CITRUS FLAVOR. VOLATILE CONSTITUENTS OF THE ESSENTIAL OIL OF THE ORANGE (CITRUS SINENSIS)

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The nature of the characteristic flavor of the orange has intrigued researchers for ages. The flavor of citrus products, e.g., juices, is derived largely from the essential oil expressed from the sacs of the epicarp of the fruit. Analyses by means of gas-liquid chromatography (GLC) of the essential oil from California oranges revealed the presence of over 50 components. A preliminary separation of the intact oil by liquid-solid chromatographic techniques into two major fractions was made. These fractions consisted of the terpene hydrocarbons and oxygenated terpenoids. Examination by GLC of the terpene hydrocarbon fraction revealed it contained 15 constituents, a number of which have been tentatively identified. The oxygenated terpenoid fraction contained some 37 distinct constituents, many of which have been tentatively identified. These techniques have increased resolution and indicated the presence of some sixteen additional compounds.

A tentative identification of the constituents was accomplished by calculation of corrected relative retention volumes and comparison of these with values for known compounds. A number of stationary liquid phases was employed and these data lend credence to the tentative assignment of identities of the constituents isolated. In addition infrared examination of collected fractions has made possible partial identification of components.

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A STUDY OF BEEF IRRADIATION FLAVOR BY MEANS OF CONCURRENT RADIATION-DISTILLATION

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The concurrent radiation-distillation technique (Proctor *et al, Food Technol., 13,* 94, 1959) has been applied to the investigation of volatile components of irradiated beef. Modification of the basic radiation-distillation apparatus to allow isolation of the volatile components produced, has been carried out. The odor produced by these substances in the resulting aqueous distillate was found to be typical of irradiated beef.

Advantages of the technique for investigation of the irradiation flavor are discussed. Characterization of the volatile compounds thus produced is described.

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THE PRODUCTION OF IRRADIATED ODORS FROM BEEF PROTEIN FRACTIONS AND THEIR DERIVATIONS

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This report concerns the nature of some odors produced by gamma irradiation of several beef protein fractions. Ammonium sulfate precipitation of an extract prepared by boiling produced an electrophoretically homogeneous fraction which exhibited the "wet dog" odor while the "wet chicken feather" odor was produced from a cold water extract. The "raw irradiated beef" odor arose from a cold saline extract. The significance of these observations with respect to protein classification is discussed.

Tryptic digestion prior to irradiation markedly reduced the production of off-odors from the non-dialyzable residue and also changed the nature of the odor produced from the dialyzables formed in this digestion. Sulfation and performic acid oxidation, but not amino-acetylation, prevents or masks irradiated odor formation. The dialyzables formed by treatment of the protein with 8 M urea give an altered odor when irradiated.

Whereas the carbonyl reactive "wet chicken feather" odor is both distillable and extractable with methanol, the sulfhydryl reactive "wet dog" odor is not distillable or extractable and is lost from both fractions when dialyzed. The odors are released from an irradiated sample only upon the addition of water and are short-lived. Exclusion of oxygen prior to irradiation does not prevent odor formation.

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MAPLE SIRUP. XVI. THE ISOLATION AND IDENTIFICATION OF COMPOUNDS CONTRIBUTING TO THE FLAVOR OF MAPLE SIRUP

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Modern techniques of isolation and identification have been applied in studying the development of flavor in maple sirup. The maple flavor was completely removed from maple sirup by chloroform extraction. This isolate was fractionated by differential solubility, and the fractions further separated by crystallization and chromatography. The pure compounds obtained by this procedure were characterized by elemental analyses, chemical reactions, melting points, derivative formation, and infrared and ultraviolet light absorption. Among a number of compounds isolated from chloroform extract, vanillin and syringaldehyde have been identified.

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BEEF QUALITY AS AFFECTED BY DELAYED GROWTH DUE TO PROTEIN DEFICIENCY

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Beef carcasses of animals which suffered protein deficiency during an age period of normally rapid growth were compared with carcasses of animals which did not undergo the stress conditions. The investigation included physical and/or chemical measurement of weights, yields, % fat, % lean, % free and bound water, color, tenderness and cooking losses; and sensory evaluation of color, tenderness, juiciness and flavor. The most significant result was a lighter color beef from those animals which underwent stress.

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VARIATIONS IN MARBLING, COOKING YIELD AND EATING QUALITY OF PORK CHOPS FROM MEAT-TYPE AND FAT-TYPE HOGS

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An investigation was conducted on pork cuts from 48 hog carcasses varying in back fat thickness from 1.0 to 2.3 inches. Information on chilled weight, carcass weight, backfat thickness, sex, grade and weight of loin before and after trimming was supplied by the packing company for all the animals in this study. The statistical pattern for the experiment consisted of an incomplete block design of paired comparisons and the backfat thickness of the two animals tested on any one day differed by 0.4 of an inch or more. Although 4 loins, right and left loins from two animals, were used each day of the experiment, one loin from each animal was randomly selected to be cooked and the other loin from each animal was used for measurements made on raw pork. Although tests were made on various pork cuts, this report will discuss only the results obtained on the braised pork chops.

This paper presents the results of measurements made on rib and loin chops and discusses the relationship of the backfat thickness of hog carcasses to: (1) cooking losses; (2) raw and cooked yield of fat, lean, bone and inedible waste (3) tenderness, measured by shear force; (4) marbling scores; and (5) quality as determined by sensory evaluations on flavor, tenderness and juiciness of the meat.

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SOME FACTORS ASSOCIATED WITH TENDERNESS OF POULTRY MEAT

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Many different factors have been listed in the literature as possible contributors to tenderness or lack of tenderness of meat. The ante mortem and post mortem factors are listed and compared as to relative degree of effect. To date the factor having the greatest effect is aging. The rate of aging can be modified by ante mortem treatment, killing procedure and cooling procedure.

Tenderness of poultry meat is affected by cooking or partial cooking treatment prior to freezing. The use of gamma irradiation at either pasteurizing or sterilizing dosages results in a decrease in tenderness. Tabular data relative to these effects are presented and discussed.

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SOME BIOCHEMICAL CHANGES OCCURRING IN EXPERIMENTALLY INFLICTED POULTRY BRUISES

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Studies were conducted to investigate some of the enzymatic and physical changes occurring in experimentally inflicted bruises, contused using an instrument to produce a standard type bruise on the breast of 8–10-week-old chickens. Proteolytic activities were detected in the damaged areas and found to be influenced by many factors such as previous bruising, severity, size and age of the bruised tissue. Both buffered saline and chloroform extracts of these damaged areas were qualitatively examined spectrophotometrically, immediately following bruise infliction and during healing, for their pigment content and compared with normal tissues. Bruised tissues accumulate extra-stromal hemoglobin which increased in concentration to reach a maximum within 24–48 hours. This chromprotein was degraded to biliverdin in bruises contused on birds kept at 86° F and to bilirubin on birds kept at 70° F or below. These bile pigments were detected in the bruised areas only after 12–14 hours of inflicting the bruise, increased in concentration within 2–3 days and then disseminated thereafter.

A simple color test for the determination of the age of unknown bruises (Hamdy, *et al., J. Animal Sci., 16,* 490, 1957), based on the presence of bile pigments in the bruised areas, was applied on condemned poultry bruises secured from a processing poultry plant. The results indicated that 90% of these bruises were accidentally inflicted between zero and 12–14 hours before killing these birds and that 38% of all the examined tissues are breast bruises.

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EFFECT OF ASCORBATE ON HEALING OF POULTRY BRUISES

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The effect of injecting Na-ascorbate solution or feeding poultry on basal diet enriched with ascorbic acid on the rate of healing of experimentally induced poultry bruises was investigated. Standard breast bruises were inflicted on 8–10-week-old birds and immediately injected intramuscularly with 0.5 ml (aqueous solution) of Na-ascorbate in the center of the damaged areas.

Morphological examinations of bruised tissues before and after killing the birds, detection of tissue bilirubin or biliverdin formation, and other physico-chemical tests served as criteria for accelerated healing. The effect of force applied, temperature of the chicken houses (86, 70 and 45° F) and concentration of Na-ascorbate (0.2, 2.0, and 20 mg per 0.5 ml) on the rate of healing was studied and the results indicated that bruised tissues treated daily with 0.5 ml (aqueous solution) containing 2 mg of Na-ascorbate healed at a significantly more rapid rate than untreated bruises and the bruises inflicted on birds kept at 86° F accumulated bilirubin (yellow color) rather than biliverdin (green color) probably due to the reduction of the latter by the injected ascorbate.

Various groups of pullets were placed on a basal diet enriched with ascorbic acid. Standard breast bruises were inflicted on these birds (age 8–10 weeks) and the effect of environmental temperature, force applied and ascorbic acid concentration, in the basal diet (zero, 28.6, 228.6 and 342.9 g per ton of feed) on the rate healing was studied and will be reported.

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TASTE PANEL EVALUATION OF CHICKENS FED DIFFERENT LEVELS OF PEANUT OIL MEAL, METHIONINE AND LYSINE

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Chickens fed 3 levels of peanut oil meal in their diets with and without added methionine and lysine at one level were cooked and presented to a taste panel for evaluation. Both frying and broiling were employed as methods of cooking and panel members were asked to judge white and dark meat separately. Judgments were made as to flavor, tenderness, juiciness, and aroma, using a scale from 1 to 6. The following weights are also recorded and compared: total, bones, meat, dark meat and white meat.

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A NEW AND USEFUL CHELATING AGENT FOR PRESERVING THE NATURAL COLOR OF MARINE PRODUCTS, MEATS AND VEGETABLES

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The disodium calcium salt of ethylenediamine tetraacetic acid (EDTA) proved extremely effective in preventing black, blue and dark discolorations in many types of canned foods including shrimp, lobster, crab, meats, fish, chicken and non-acid vegetables. Chelates or complexes of metals such as lead, copper, tin and iron are formed and render the metallic ions inactive and non-reactive. Calcium and magnesium are also complexed. Thus, copper and iron from the blood, flesh, water, brine or metallic container are neutralized by chelation to form harmless soluble salts. Smut, black, blue and dark discolorations are avoided resulting in marked improvement in the canned food. The use of EDTA in blanching water for canned vegetables removes metal traces and Ca and Mg. The latter often cause toughness in peas, sweet corn and snap beans. By combining EDTA with aluminum salts, struvite crystals may be prevented from forming in canned shrimp, crab, lobster and fish. Effective concentrations for most uses range from 50 to 400 ppm.

Acute and chronic toxicity studies with rats show that at feeding levels of 0.5 to 1.0%, approximately 94% of the EDTA is recovered in the urine and feces in 48 hours. Little, if any, of the EDTA is metabolized in the body. At 1.0 and 0.5% feeding levels for 2 years no harmful effects resulted. The histology of the organs was normal. No tumors were noted. Reproduction was not impaired. Even at low mineral levels (one-half normal) no tooth erosion occurred when $Na_2CaEDTA$ was fed for as long as 270 days. Blood coagulation time remained normal as did the Ca content of the blood serum. All the toxicity data indicate that EDTA is non-toxic to rats at the high feeding levels used. In the range of effectiveness of 50 to 400 ppm, it should constitute no health hazard if used as a food additive.

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COMPARATIVE STUDIES ON MEDIA FOR COUNTING ANAEROBIC BACTERIAL SPORES. II.

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This investigation is a continuation of the studies conducted with the cooperation of 26 laboratories, the first results of which were presented at the 1958 meeting of the Institute of Food Technologists. (*Food Research, 24*, 134–145, 1958).

The early work involved only one strain of P.A. 3679 in relation to the effect of the cultural media on the rate of recovery of thermally processed spores. Ten media were employed for this phase.

The present study covers the use of the original ten media plus an additional six in determining their capacity to enhance spore outgrowth of two additional strains of PA 3679. These two strains were obtained from two of the collaborating laboratories.

Seeking to add further information about the nutritional requirements of anaerobic spores, one new phase has been incorporated in the program. This concerns the environmental conditions of spore production and its ultimate effect on the recovery rate of thermally processed spores as determined by the subculturing media or substrate.

With the cooperation of four other laboratories, 5 spore suspensions from a strain of PA 3679 have been studied. These suspensions were prepared with varying conditions of media substrate, conditions of anaerobiosis, and final spore concentration. These suspensions have been employed in ascertaining the relationship between methods of spore production and the growth response to the 16 media under study.

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THERMAL RESISTANCE OF *CLOSTRIDIUM SPOROGENESIS* (PA 3679) AT THE INTERMEDIATE pH RANGE

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The ultimate objective of this work has been the establishment of the basic kinetics of thermal destruction of the major food spoilage sporeforming bacteria at the intermediate pH range (pH 4.5–5.3) in both reference heating menstrua and various formulated semi-acid food models.

In an extensive preliminary survey the optimum conditions for sporogenesis, recovery of severely heated spores and the reference heating menstrum were established.

Thermal death rates were then established in M/2 aconitate buffer at pH 4.5, 4.7, 4.9, 5.1 and 5.3, and 104.4, 110, 115.5 and 121.1° C (210, 220, 230, 240, and 250° F). The "D" values were computed from the linear regression coefficients of the thermal destruction rate curves. The data demonstrated a highly significant effect of pH on the destruction rate, but only at the lower heating temperature range, 104.4 and 110° C (210 and 220° F). Such effect diminished gradually and finally became insignificant at 121.1° C (250° F).

A similar pattern of study was repeated, using a tomato-meat sauce as the heating menstruum, a representative of the semi-acid foods. The effect of both the fat and meat levels in the formulated product was also evaluated. Data showed a different trend for the pH effect on the death rates. Significant differences in computed "D" values were encountered only at the lowest and highest heating temperatures used, while at the intermediate ones no significant differences could be found. Neither the meat, nor the fat, at the pH and levels tested, exhibited significant effects upon the death rates.

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LOW TEMPERATURE HANDLING OF STERILIZED FOODS. III. MEDIUM FOR ESTABLISHING REQUIREMENTS FOR SPORULATION BY A CLOSTRIDIUM

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Presence of spoilage forms in canned foods necessitated the use of heat for preservation. Temperatures used were established on the unique heat resistance of Clostridial spores. This heat resistance is first demonstrable during the last stage of spore formation and therefore is a culmination of an integrated series of previous biochemical transformations. The mechanism of spore formation therefore holds the key to heat resistance. An approach to the understanding of the mechanism is to cause sporulation in a defined synthetic medium and to investigate deletions or substitutions of the ingredients upon heat resistance.

This preliminary report discusses the development of a synthetic medium for the growth of a variant of PA 3679. This organism differed from the original strain in that it ferments ribose and mannose. In this study the organism was found to require arginine and thiamin for growth. The synthetic medium developed was found to be asporogenic and therefore numerous factors were investigated in an attempt to cause sporulation of the anaerobe. The significance of the factors is discussed.

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NUTRITIONAL STUDIES ON *LACTOBACILLUS HETEROHIOCHI*, AN ORGANISM CAUSING SPOILAGE OF JAPANESE RICE WINE (SAKÉ)

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The recently described species of lactic acid bacteria which cause spoilage of Saké ("hiochi bacteria") either require or are stimulated by mevalonic acid. One of these microorganisms, *Lactobacillus heterohiochi* H1, generously supplied by Dr. G. Tamura of the University of Tokyo, failed to grow in a semi-synthetic medium which supports growth of another mevalonic requirer, *Lactobacillus acidophilus* 4963, unless the medium was supplemented with yeast extract (YE). Studies were initiated to replace YE with known compounds.

Preliminary studies revealed the *L. heterohiochi* requires 5 mcg per ml of mevalonic acid (dibenzylethylene diammonium salt)—10 times the level required by *L. acidophilus*. Further experiments showed that N-Z-Case (enzymatic casein digest) spared the YE requirement. Using medium supplemented with N-Z-Case and high levels of mevalonate, it was shown the YE activity was split by ion exchange into two fractions, A and B, both of which were required. In a medium supplemented with A, B was replaceable by 4 mcg per ml pantothenic acid, 40 times the amount present in the basal medium. Similarly, A could be replaced by 1 mcg per ml nicotinic acid, 10 times the concentration in the basal medium.

Thus, by increasing mevalonic, pantothenic and nicotinic acids and supplementing with N-Z-Case, good growth could be obtained. The requirement for N-Z-Case could be fully replaced by YE and partially by 10 mcg per ml L-asparagine. A combination of L-glutamate, L-serine, L-glutamine and L-asparagine at high concentrations (3 mg per ml) produced an additional stimulation indicative of a peptide requirement. This amino acid effect was markedly enhanced by ascorbic acid. L-cysteine (0.5 mg per ml) and ethanol (40 mg per ml) further stimulated growth. In this highly supplemented medium, YE elicited a further response which could be replaced by increasing the nicotinic acid level once again.

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DEFROST TEMPERATURES OF SOME PREPARED FROZEN FOODS AND THE EFFECT OF DEFROST CONDITIONS ON MICROBIOLOGICAL POPULATIONS

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In a determination of the effect of defrosting on the microflora and the organoleptic characteristics of frozen food, it is useful to establish an objective measurement of defrost. Knowledge of the exact defrost temperature of the product can be used in determining the length of time necessary to produce a defrosted product, effectiveness of storage temperatures, and the time necessary to produce a product which is bacteriologically and/or organoleptically unacceptable. Time-temperature relationships of several types of prepared frozen foods held under controlled conditions that allowed defrost were determined by means of a recording potentiometer. Organoleptic criteria for the determination of defrost were established. Using the data obtained from the controlled defrost of the products, the defrost temperature of each product examined was calculated. The effect of varying storage condition above the defrost temperature on the numbers and types of microorganisms present in the product was determined using the actual defrost temperature as an objective criterion of defrost. Determinations were made on product that has been defrosted and on product that had been defrosted and refrozen. Total bacterial populations of coconut custard pies held in the defrosted state at 10° C (50° F) for 24 hours and at 4.4° C (40° F) for 48 hours showed no appreciable increase in numbers. In chicken pot pies held under similar conditions, total bacterial populations of the pies held at 10° C (50° F) increased within 24 hours and those held at 4.4° C (40° F) increased significantly after being held for 48 hours. Numbers of organisms in pies held at 1.7° C (35° F) for 96 hours did not increase. Information on the pH, moisture content and appearance of the products also was obtained.

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ACTIVITY OF A PSYCHROPHILE AND ITS CELL-FREE ENZYMES ON CERTAIN COMPONENTS OF FROZEN MEAT PIES

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Psychrophilic bacteria and potent enzymes liberated in defrosted frozen food products by these bacteria have been shown to be responsible for adverse changes in flavor, odor and appearance of these products. Investigation of the proteolytic, lipolytic and amylolytic enzymes and their production by a psychrophilic bacteria seemed to include the most prominent and undesirable effects due to bacterial action during defrost. We have observed defects in meat pies brought about by storing these pies at defrost temperatures after treatment with bacteria-free endocellular sonic extracts of a psychrophilic culture of *Pseudomonas fluorescens* and extracellular enzymes from the broth medium in which the culture had been grown. These defects simulate those previously observed with defrosted frozen foods. Elaboration of lipolytic and amylolytic enzymes by this bacteria is an important part of its destructive action on the meat pie ingredients. Great reductions in starch gel viscosity as a result of enzyme action and decreases in emulsification of fat in the gravies were noted. Addition of the endo- and extracellular preparations to meat pies and to simple white sauces resulted in titratable increases in free fatty acids and in starch degradation products. Determinations of lipase and amylase activity by psychrophilic bacteria developing in meat pies stored at defrost temperatures were carried out on water extracts of the gravy. Both enzymes showed a single peak of elaboration. We have attempted to fractionate by column chromatography on diethylaminoethyl cellulose the amylolytic, lipolytic and proteolytic enzymes from the endocellular sonic lysed culture materials and also those obtained extracellularly by ammonium sulfate precipitation of the broth medium in which the culture was grown. Certain fractions have been identified as having these activities.

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ACTION OF ANTHOCYANIN PIGMENTS AND RELATED COMPOUNDS ON GROWTH OF CERTAIN MICROORGANISMS

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In prior studies it has been reported from this laboratory that cyanidin 3-monoglucoside, delphinidin 3-monoglucoside, and pelargonidin 3-monoglucoside influence the growth of certain bacteria and that breakdown products of pelargonidin 3-monoglucoside inhibit the growth of some organisms. It has been reported from laboratories at the University of Bordeaux that the aglucone of malvidin 3-monoglucoside is bacteriocidal toward certain enteric organisms. The purpose of this study was to compare (1) extracted, purified anthocyanin pigments against the same genera by the same methods and (2) purified natural pigments with synthetic anthocyanin pigments. Data will be reported concerning the microbial action of the pigments and their degradation products, characterization of intermediate and end-products, and possible explanation of inhibitory and stimulatory effects observed on the test organisms.

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IN VITRO EFFECTS OF CHLORTETRACYCLINE ON BACTERIA INDIGENOUS TO GULF SHRIMP AND OYSTERS

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Employment of chlortetracycline in dips and washes prior to packing has been shown to be beneficial in extending the storage life of iced shrimp and oysters obtained from the Gulf of Mexico. Experimental evidence indicates this prolonged quality retention is the result of maintaining reduced bacterial counts in CTC treated samples. Microorganisms commonly found on these seafoods in their environment have been isolated, identified and tested for their ability to survive and grow in media containing various concentrations of CTC. Most of the organisms isolated were inhibited by 20 ppm or less. The Food and Drug Administration is now considering a request to extend the use of CTC to cover processing these products when destined for specific uses.

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ANALYSIS OF HEADSPACE GASES IN CANNED FOODS BY GAS CHROMATOGRAPHY

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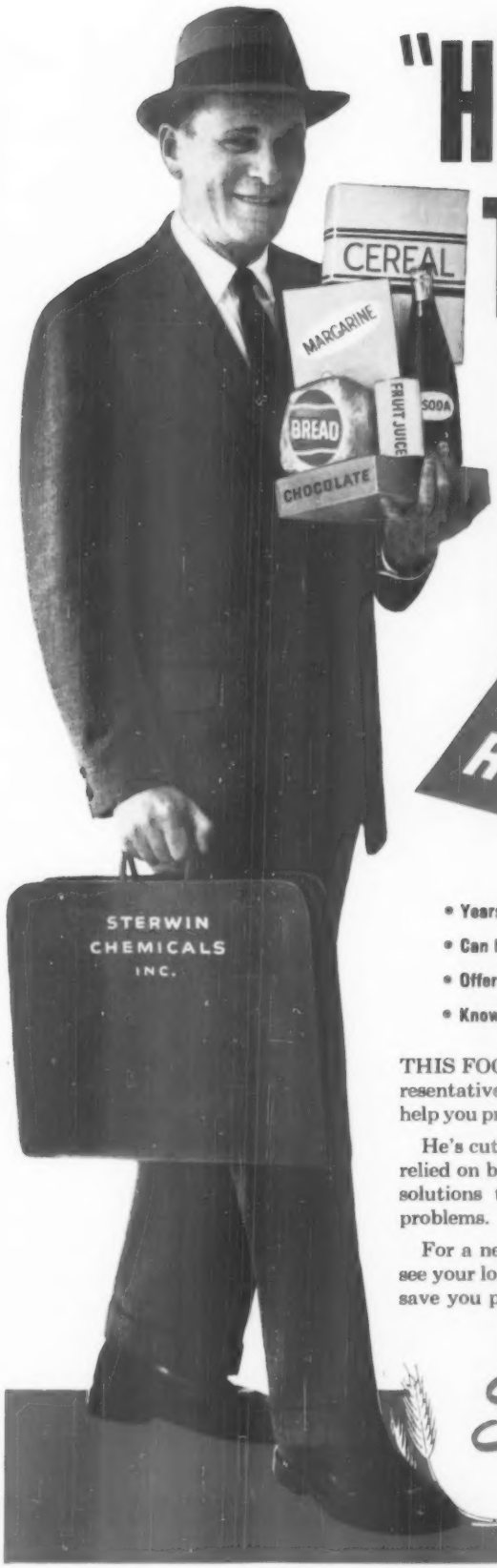
The composition of headspace gases in canned foods serves as an important index of container corrosion, bacterial spoilage, or product deterioration. Gas chromatographic techniques were developed which permit the simultaneous analysis of as little as 250 microliters of a mixture of CO_2, H_2, N_2, and O_2. This separation is accomplished using a two-stage column and two thermal conductivity detectors. This apparatus and representative analyses are described.



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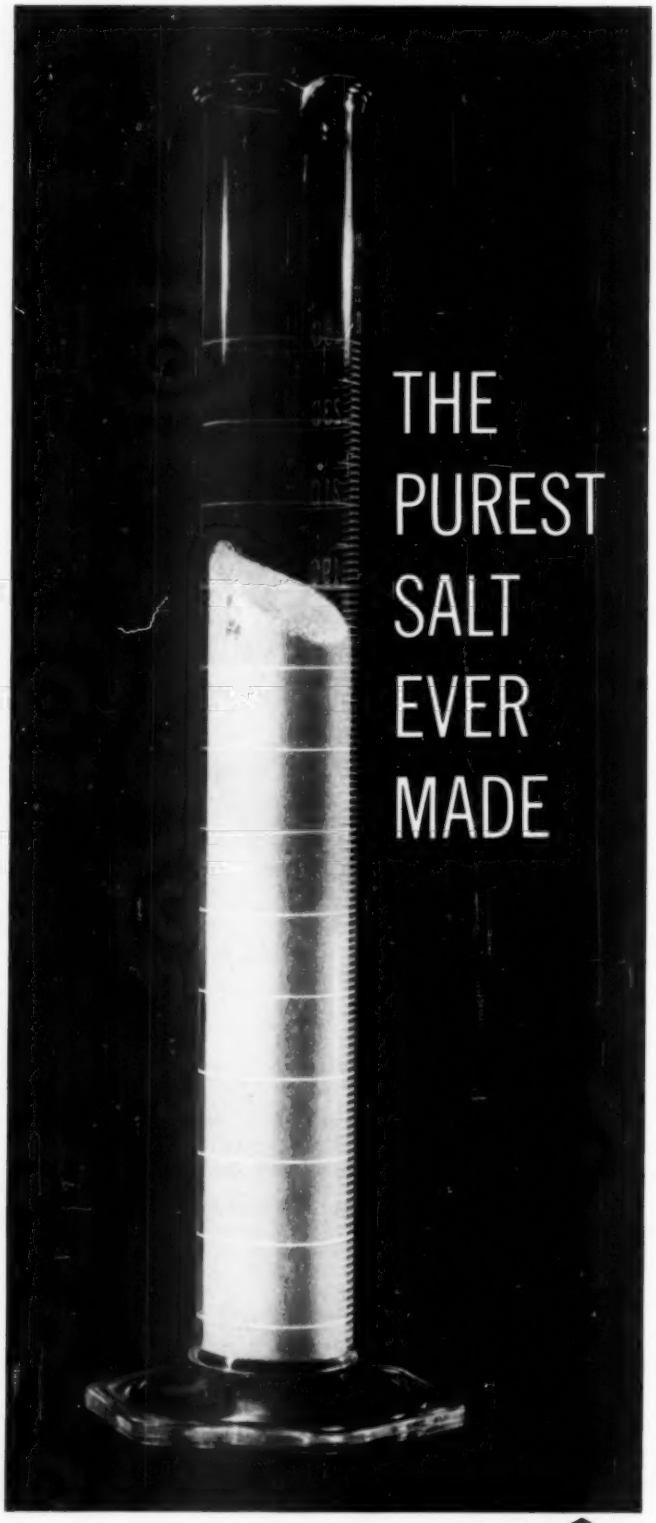

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The Effect of Degree of Doneness on the Tenderness and Juiciness of Beef Cooked in the Oven and in Deep Fat*

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(Manuscript received October 8, 1959)

THE EFFECT OF THE DEGREE of protein coagulation, as determined by internal temperature, on the tenderness and juiciness of beef has been studied by several workers. However, the data do not agree and are limited to certain muscles and internal temperatures. Satorius and Child *(6)* reported that when the *semitendinosus* muscle was roasted to three internal temperatures (58°, 67°, and 75° C), shear values and diameter of the muscle fibers decreased as the internal temperature increased from 58° to 67° C. Shear values increased, but the diameter of the fibers did not change between 67° and 75° C. Press fluid and total moisture decreased up to 58° C and between 67° and 75° C, but not between 58° and 67° C. Total cooking losses were increased with each increment in internal temperature.

The *longissimus dorsi* muscle from U. S. Commercial rib roasts and Porterhouse steaks cooked to 158° F (70° C) by Harrison, Vail, Hall, and Mackintosh *(2)* was scored significantly more tender than that cooked to 176° F (80° C). Shear values for rib roasts, but not for Porterhouse steaks, were significantly lower when cooked to 158° F than when cooked to 176° F. Moreover, differences in the tenderness scores and shear values for the *longissimus dorsi* muscle from club and T-bone steaks broiled to 158° F were not significantly different from those broiled to 176° F. Juiciness scores and press fluid yields for the rib roasts and loin steaks were significantly higher for meat cooked to 158° F than for that cooked to 176° F.

No significant differences were noted by Hood, Thompson, and Mirone *(3)* in the tenderness of U. S. Commercial and U. S. Good *biceps femoris* steaks broiled to 160° F (71.1° C) and 176° F (80° C). However, the steaks cooked to 160° F were significantly juicier than those cooked to 176° F.

In the study reported here, three experiments were designed in which tender and less tender beef muscles were cooked to internal temperatures representing rare, medium-, and well-done beef.

EXPERIMENTAL PROCEDURE

Meat used. U. S. Good paired long hindquarters (the round, tenderloin, and loin separated from the chuck between the fourth and fifth rib) from 12 animals were purchased from a commercial packing company. The long hindquarters were aged 7 to 10 days and processed as needed. Two roasts were cut from each *psoas major*, *adductor*, *rectus femoris*, and *vastus lateralus* muscle. The *semimembranosus* was divided into the anterior and posterior portions and each part was cut into 2 roasts. Three roasts were cut from the *semitendinosus* muscle. The *longissimus dorsi* was divided into the rib and loin portions and each of these was cut into 3 roasts.

Roasts, ranging from 1 to 2 lb, were wrapped in 0.0015 gauge aluminum foil, frozen, and stored in an upright home freezer (−20° F) for 8 to 12 weeks. Wrapped roasts were defrosted in a refrigerator (40° to 46° F) for approximately 48 hr. Muscles from 6 animals were used for oven roasting, muscles from 3 animals for deep fat cooking at 110° C, and those from 3 animals for deep fat cooking at 100° C.

Experiment I. Oven Roasting

Roasts were placed on a rack in a shallow pan, and roasted in a 300° F rotary hearth gas oven to an internal temperature of 55°, 70°, or 85° C. The internal temperature was measured by a thermometer placed in the center of the roast, and read through a window in the oven door. Time required for each 5° C rise in internal temperature was recorded until the roast reached 55° C, and thereafter each 2° C rise was noted.

Experiment II. Deep Fat Cooking, 110° C

Several authors *(1, 4, 5)* have reported the use of deep fat as a cooking medium for experimental work on beef. Harrison, Lowe, McClurg, and Shearer *(1)* cooked beef muscles to an internal temperature of 70° C in fat held at 96° to 98° C, whereas Ramsbottom, Strandine, and Koonz *(5)* used a temperature of 121.1° C to cook muscles to 76.7° C. Paul and Bratzler *(4)* cooked 1-in steaks to 63° C in fat maintained at 147° C.

In preliminary work for this study, roasts were cooked in a hydrogenated vegetable fat at 120° and 147° C. At the higher temperature (approximately the same as the oven temperature used in Experiment I) the meat shrank considerably and a thick, hard crust formed on its surface. At 120° C this effect was not so pronounced as at 147° C, but it seemed desirable to try a lower temperature. After further work the following procedure appeared to be satisfactory, and was used in the experiment. The fat was heated to 120° to 127° C, the roast added, and the temperature of the fat allowed to drop to 110° C where it was maintained during the cooking period. Two or 3 roasts were cooked simultaneously in separate household electric deep fryers to an internal temperature of 55°, 70°, or 85° C, as measured by a thermometer in the center of the roast. Time required for each 5° C rise in internal temperature was recorded.

* Contribution No. 218, Department of Home Economics, and No. 235, Department of Animal Husbandry, Kansas Agricultural Experiment Station, Manhattan.

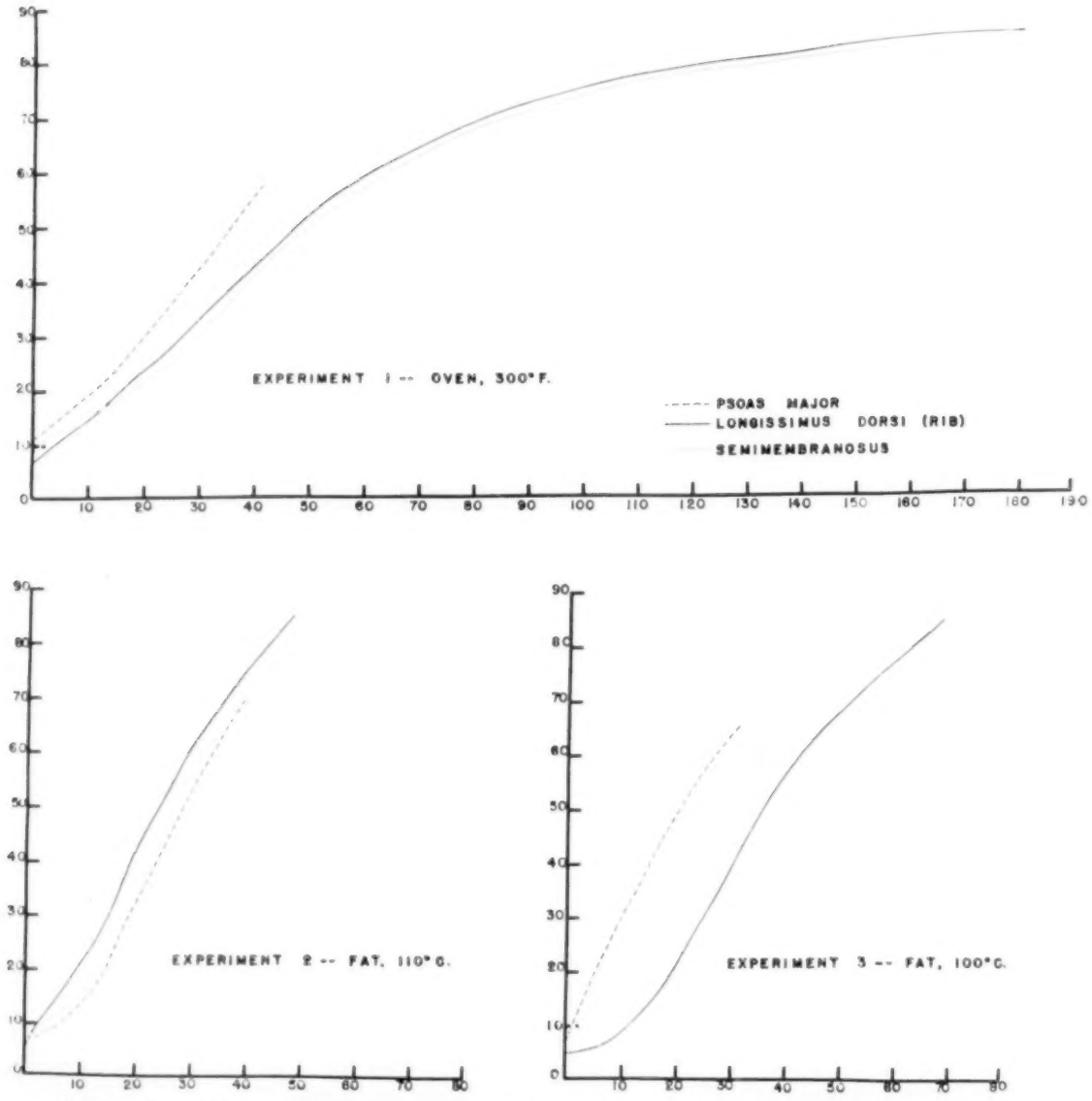

Figure 1. Rate of heat penetration curves for psoas major, longissimus dorsi (rib), and semimembranosus muscles.

Experiment III. Deep Fat Cooking, 100° C

Results of Experiment II indicated that both lower cooking and internal temperatures were necessary to obtain meat comparable to the usual conception of rare and medium-done beef. After preliminary work, a cooking temperature of 100° ± 4° C and internal temperatures of 45°, 65°, and 85° C, as measured by a thermometer, were selected. Time required for each 5° C rise in internal temperature was recorded.

DATA OBTAINED

Data were recorded to determine rate of heat penetration, percentage cooking losses, and cooking time in min per lb. A 1-in core of meat, cut parallel to the fiber axis through the center of each roast, was sheared 5 times on a Warner-Bratzler shearing apparatus.

A palatability panel scored slices of similar thickness from approximately the same position in every roast. Scores from one, *extremely poor*, to 10, *extremely good*, were given each sample for juiciness and tenderness.

After samples for the shearing and palatability tests were removed, the remainder of each roast was ground in a Universal No. 3 food grinder. Duplicate 25-g samples were pressed in a Carver Laboratory Press until a pressure of 4,000 psig was obtained according to a specific 15-min schedule. After the pressure was released, the fluid was transferred to a graduated centrifuge tube and allowed to stand overnight before reading the volume of total press fluid, serum, and fat to the nearest 0.1 ml.

STATISTICAL DESIGN AND ANALYSIS

In each experiment a randomized incomplete block design was used to determine end point of cooking for the roasts from the *semitendinosus*, *longissimus dorsi* (rib), and *longissimus dorsi* (loin). An incomplete block consisted of the 6 roasts (3

from the right and 3 from the left side) from a muscle, and a muscle from one animal was one replication. A randomized complete block design was used to determine end point temperature for the 4 roasts (2 from the right and 2 from the left side) from each of the other muscles. One replication of roasts was cooked in a single period and in random order.

In Experiments I and III when muscles were cooked to 3 internal temperatures, data obtained within each of the experiments were subjected to analyses of variance to determine the effect of degree of doneness on: (1) cooking losses, (2) cooking time, (3) shear value, (4) press fluid yield, and (5) palatability factors. In appropriate cases least significant differences were calculated. The t-test was used to analyze data for these factors when muscles were cooked to two temperatures. In Experiment II the data for these factors for all muscles were subjected to analyses of variance, and when appropriate, least significant differences were calculated.

In all 3 experiments correlation coefficients were determined for tenderness scores and shear values and juiciness scores and press fluid yields. For each cooking method correlation coefficients were run on the data for roasts from each muscle cooked to each internal temperature.

RESULTS AND DISCUSSION

Rate of heat penetration and degree of doneness. Heat penetration curves, representative of roasts of various weights and shapes, from the 3 experiments are given in Figure 1. Smallest roasts weighed approximately 1 lb and were from the long, slender *psoas major* muscle. Broad, flat roasts from the *longissimus dorsi* weighed about 1½ lb; and blocky compact roasts from the *semimembranosus* weighed approximately 2 lb.

Curves for roasts cooked in deep fat are steeper and shorter than those for oven roasts. At a given temperature the heat conductivity of liquid fat is about 6 times that of air. Hence, the fat transferred heat to the meat more rapidly than the air in the oven, although the temperature of the fat was less than that of the oven. After cooking was terminated, the roasts stood at room temperature until the maximum internal temperature was noted. The internal temperature of the oven roasts did not rise. When meat was cooked in deep fat at 110° C, the internal temperature of roasts cooked to 55° C rose 10 to 13°, and the temperature of roasts cooked to 70° C rose 5 to 6°. Consequently, there were no samples representative of rare and medium-done meat. The rise in temperature of roasts cooked to 85° C was negligible. The rise in internal temperature for roasts cooked in deep fat at 100° C to 45° and 65° C was approximately 10 and 5°, respectively, and that for roasts cooked to 85° C was negligible. In this experiment all roasts were similar in external appearance. The surface was the grey-brown color of cooked meat, but was not the rich brown characteristic of the oven roasts. The center of roasts cooked to 45° C was a bright pink, and exuded red juice. The pink gradually faded to a grey-brown around the edge. The center of roasts

TABLE 1

Average cooking time and cooking losses for each muscle

Muscles	Internal temperature °C	Cooking time, min/lb			Cooking losses, %		
		Oven 300° F	Fat 110° C	Fat[1] 100° C	Oven 300° F	Fat 110° C	Fat[1] 100° C
Psoas major	55	38.9	22.8***	20.3***	8.4***	22.1***	17.4***
	70	62.3***	28.6***	33.2***	14.6***	27.5***	23.2***
Adductor	55	.....	.....	26.3**	.....	.....	21.5
	70	72.9***	38.3**	34.4**	21.6***	33.7***	25.4
	85	128.4***	46.2**	.....	36.0***	37.7***	.....
Rectus femoris	55	.....	.....	25.8**	.....	.....	24.4**
	70	68.1***	33.3	38.2**	20.6***	34.1*	31.3**
	85	123.2***	42.3	.....	36.2***	37.6*	.....
Vastus lateralus	55	.....	.....	21.0***	.....	.....	20.8***
	70	55.4***	30.6**	32.2***	19.9***	34.3	29.4***
	85	103.7***	41.0**	.....	35.3***	37.7	.....
Semimembranosus (post.)	55	.....	.....	22.2***	.....	.....	20.2
	70	60.4***	28.3**	31.7***	18.6***	32.1**	24.6
	85	112.7***	36.1**	.....	33.0***	36.7**	.....
Semimembranosus (ant.)	55	.....	.....	21.8***	.....	.....	22.8***
	70	61.3***	27.2***	29.8***	21.1***	33.3**	30.7***
	85	104.3***	35.5***	.....	37.1***	37.7**	.....
Semitendinosus	55	48.2*	30.2*	26.0*	10.9*	26.9*	17.4*
	70	70.6*	38.3*	36.6*	18.8*	29.8*	25.1*
	85	136.3*	48.3*	62.6*	33.4*	35.0*	35.3*
lsd*		9.6	3.5	8.0	1.5	1.4	2.4
Longissimus dorsi (loin)	55	35.1*	22.3	19.2*	10.0*	27.5*	17.6*
	70	59.0*	26.9*	29.8*	17.8*	31.9*	26.8*
	85	122.5*	34.5*	50.1*	35.6*	34.7*	35.2*
lsd*		8.1	6.7	5.5	1.7	2.8	2.3
Longissimus dorsi (rib)	55	38.5*	26.2*	24.9*	9.1*	32.1*	23.0
	70	60.6*	32.7*	35.1*	16.2*	35.8*	28.5
	85	127.7*	40.7*	51.4*	33.6*	28.6*	35.5*
lsd*		9.4	3.7	7.4	1.8	1.4	5.9

[1] End points for meat cooked in fat at 100° C were 45°, 65° and 85° C.

* Significant at the 5% level.

** Significant at the 1% level.

*** Significant at the 0.1% level.

lsd* = least significant difference at the 5% level.

TABLE 2

Average tenderness scores and shear values and the correlation coefficients for these factors

Muscle	Internal temperature ° C	Tenderness score[1]			Shear values, lb			Correlation coefficients		
		Oven 300° F	Fat 110° C	Fat[2] 100° C	Oven 300° F	Fat 110° C	Fat[2] 100° C	Oven 300° F n = 12	Fat 110° C n = 6	Fat[2] 100° C n = 6
Psoas major	55	9.4	9.2	9.1	14.8	11.9	11.0	−.458	−.471	−.858*
	70	9.3	9.2	9.0	12.2***	13.3	14.0	−.633*	−.392	−.332
Adductor	55	.....	.....	7.6	.....	.....	17.9	.....	.....	.169
	70	8.1	7.9	7.4	20.4	28.4	21.2	−.566	−.481	−.794
	85	7.9	7.9	.....	24.7	26.5	.....	−.914***	−.185	.....
Rectus femoris	55	.....	.....	7.7	.....	.....	17.4	.....	.....	−.036
	70	8.5	8.2	8.1	17.2	23.5	20.6	−.500	−.153	−.359
	85	8.3	8.3	.....	18.1	26.3	.....	−.624*	−.892*	.....
Vastus lateralus	55	.....	.....	7.8	.....	.....	20.4	.....	.....	.639
	70	7.8	8.1	7.8	19.6	24.6	19.6	−.506	−.628	.825*
	85	8.0	8.2	.....	19.5	21.6	.....	−.701**	.088	.....
Semimembranosus (post.)	55	.....	.....	7.5	.....	.....	21.8	.....	.....	−.497
	70	7.8	8.2	7.1	24.3	29.2	23.6	−.364	−.386	−.540
	85	7.8	8.4	.....	23.8	25.4	.....	−.495	−.455	.....
Semimembranosus (ant.)	55	.....	.....	7.2	.....	.....	17.3	.....	.....	−.715
	70	7.9	7.9	6.9	24.1	27.6	22.0	.110	−.701	−.512
	85	7.7	8.3	.....	26.4	27.6	.....	−.248	−.816*	.....
Semitendinosus	55	8.5	8.3	8.0	30.8	21.7	31.3	.059	.217	−.381
	70	8.4	8.4	7.6	20.3	21.7	21.9	−.307	−.068	−.203
	85	8.5	8.4	7.9	20.0	20.7	21.9	−.456	.121	−.730
lsd*					4.8					
Longissimus dorsi (loin)	55	8.9	8.7	8.1	14.3	13.2	13.0	−.554	−.269	−.700
	70	8.6	8.4	8.2	14.0	17.2	13.6	−.001	−.908*	.091
	85	8.6	8.7	7.9	15.3	15.1	14.7	−.715**	−.480	−.511
lsd*		0.17								
Longissimus dorsi (rib)	55	9.1	8.4	8.6	15.0	16.8	13.4	−.373	−.296	−.667
	70	8.9	8.7	8.1	14.4	15.8	14.7	−.397	−.262	−.047
	85	8.7	8.7	7.8	17.5	15.4	16.3	−.729**	−.463	−.779
lsd*		0.3								

[1] Maximum score possible, 10.
[2] End points for meat cooked in fat at 100° C were 45°, 65° and 85° C.
lsd* = least significant difference at the 5% level.
* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the 0.1% level.

cooked to 65° C was a light pink that faded to grey-brown about half way through the roast, whereas the interior of roasts cooked to 85° C was a uniform grey-brown. The inside appearance of the roasts cooked in the oven was typical of the general conception of rare, medium-, and well-done meat.

As a result of the endothermic process of protein coagulation, the rise in temperature of oven roasts was slower after 55° C was reached than in the earlier part of the cooking period. Rate of heat penetration in roasts cooked in fat was about the same throughout cooking.

Cooking time and losses. Average cooking time, in min per lb, and percentage total cooking losses for the roasts are presented in Table 1. As the internal temperature of the meat increased, average cooking time increased significantly, and was accompanied by a significant increase in cooking losses for all roasts except those from the *adductor* and *semimembranosus* (posterior) cooked in deep fat at 100° C. The effect of internal temperature on cooking time and losses was most pronounced in oven roasts and least pronounced in those cooked in deep fat at 110° C.

When roasts were cooked to the same internal temperature, those cooked in the oven took approximately 2 to 3 times longer to reach the desired end point than those cooked in fat. When the end point temperature was 55° or 70° C, losses were greater for roasts cooked in deep fat than for oven roasts. However, when the meat was cooked to 85° C, losses were similar for all roasts.

Tenderness. Tenderness of cooked meat is the total effect of composition of muscle, aging before cooking, heat coagulation of muscle fiber proteins, and partial hydrolysis of connective tissues. Generally, it is believed that tenderness is decreased as the protoplasmic proteins coagulate and increased with softening and hydrolysis of the connective tissue. Therefore, it might be expected that tender cuts would be toughened as cooking time increased, and cuts with relatively large amounts of connective tissue would become more tender. However, in the experiments reported here, significant increases in cooking time were noted with increased internal temperature; in general, for a given muscle, average tenderness scores and shear values (Table 2) were approximately the same regardless of internal temperature.

There was little difference in tenderness scores for the oven roasts and those cooked in fat at 110° C. In most cases, average tenderness scores for roasts cooked in fat at 100° C were slightly lower than for oven roasts and those cooked in deep fat at 110° C (Table 2). Shear values for oven roasts usually were a little lower than for roasts cooked in fat. However, except

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TABLE 3

Average juiciness scores and press fluid yields and the correlation coefficients for these factors

Muscle	Internal temperature ° C	Juiciness score[1]			Press fluid yields			Correlation coefficients		
		Oven 300° F	Fat 110° C	Fat[2] 100° C	Oven 300° F	Fat 110° C	Fat[2] 100° C	Oven 300° F n = 12	Fat 110° C n = 6	Fat[2] 100° C n = 6
Psoas major	55	9.2 **	7.9	8.9	9.1	7.6	10.0	.091	−.199	.765
	70	9.0	7.6	8.0	9.4	7.3	8.9	.445	.794	−.288
Adductor	55	.....	.....	8.3	.....	.....	8.8	.....	.....	−.895*
	70	8.2 ***	5.8	6.9	8.4 ***	6.7	8.4	−.463	.510	.633
	85	6.0	5.3	.....	6.9	6.3	.....	.713**	.329	.....
Rectus femoris	55	.....	.....	8.1	.....	.....	9.1	.....	.....	−.230
	70	8.6 ***	6.6	7.0	8.4 ***	6.7	8.1	.446	.163	.246
	85	6.9	6.3	.....	6.6	6.2	.....	.254	.704	.....
Vastus lateralus	55	.....	.....	8.6	.....	.....	9.4	.....	.....	.629
	70	8.3 ***	6.6	6.8	8.4 ***	6.8	8.0	.236	.137	.058
	85	6.7	5.6	.....	7.1	5.6	.....	.007	.781	.....
Semimembranosus (post.)	55	.....	.....	8.7	.....	.....	9.4	.....	.....	.718
	70	8.5 ***	6.6	7.4	8.5 **	7.5	8.4	.393	−.740	.000
	85	6.6	6.1	.....	7.3	6.3	.....	−.374	.091	.....
Semimembranosus (ant.)	55	.....	.....	8.0	.....	.....	9.3	.....	.....	.275
	70	8.1 ***	6.0	6.7	8.6 ***	7.3	8.5	−.261	.376	.360
	85	6.1	5.5	.....	7.2	6.1	.....	.334	−.666	.....
Semitendinosus	55	9.1	7.8	8.3	9.4	8.3	9.5	.447	.708	.104
	70	8.4 *	6.9	7.0	8.9 *	7.8	8.8	.659*	.699	.417
	85	6.6 *	6.3	6.6	7.4 *	6.9	6.4	.457	.849*	−.443
	lsd*	0.37			0.53					
Longissimus dorsi (loin)	55	9.4	7.9	9.2	8.9	7.8	9.2	−.568	−.208	.391
	70	8.8 *	6.8	7.6	8.8 *	6.6	8.1	−.258	−.439	.469
	85	6.4 *	6.0	6.2	6.4 *	5.6	6.3	.173	.330	−.247
	lsd*	0.40			0.66					
Longissimus dorsi (rib)	55	9.5	7.4	9.0	8.7	7.4	9.0	.032	−.919*	.598
	70	8.8 *	6.7	7.4	8.9 *	6.5	7.6	.515	.033	.351
	85	6.8 *	6.4	6.2	6.3 *	6.0	7.0	.432	−.126	.722
	lsd*	0.40			0.57					

[1] Maximum score possible, 10.
[2] End points for meat cooked in fat at 100° C were 45°, 65° and 85° C.
lsd* = least significant difference at the 5% level.
* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the 0.1% level.

for cuts from the *longissimus dorsi* and *semitendinosus* muscles, shear values for roasts cooked in fat at 100° C were more nearly like those for oven roasts than those for roasts cooked in fat at 110° C. This may have resulted from similar maximum internal temperatures for the 2 groups of roasts and/or less coagulation of muscle fiber proteins by fat at 100° C than by fat at 110° C. In all 3 experiments both tenderness scores and shear values indicated that the *psoas major* was most tender of the muscles studied, and usually the *semimembranosus* was least tender.

There were few significant and many low correlation coefficients for tenderness scores and shear values (Table 2). Nevertheless, the negative coefficients indicate some agreement between the 2 methods of measuring tenderness. There were more significant coefficients for roasts with an internal temperature of 85° C than for roasts with internal temperatures of 55° and 70° C. Coefficients were calculated for data from each muscle at each internal temperature. Therefore, for oven roasts there were 10 degrees of freedom for each coefficient, and for roasts cooked in deep fat at 100° and 110° C there were only 4 degrees of freedom. For oven roasts coefficients of −0.624 and above were significant, whereas for roasts cooked in deep fat no coefficients below −0.816 were significant.

Juiciness. For oven roasts and those cooked in deep fat at 100° C, both juiciness scores and press fluid yields usually decreased significantly as the internal temperature of the meat increased (Table 3). For roasts cooked in deep fat at 110° C, there were fewer significant differences attributable to internal temperature. Also, oven roasts and those cooked in deep fat at 100° C generally were scored juicier and yielded more press fluid than roasts cooked in deep fat at 110° C.

There were few significant correlation coefficients for juiciness scores vs press fluid yields (Table 3). At a given internal temperature there was little variation among muscles in total cooking losses, juiciness scores, or press fluid yields (Tables 1 and 3). However, the muscle with the lowest cooking losses did not always have the highest juiciness score nor the greatest quantity of press fluid. This may explain, in part, the many low and several negative correlation coefficients for these factors.

SUMMARY

Three experiments were conducted in which tender and less tender beef muscles from paired U. S. Good long hindquarters were cooked to rare, medium-, and well-done by oven roasting, cooking in deep fat at

110° C, and cooking in deep fat at 100° C. Rate of heat penetration was slower in oven roasts than in roasts cooked in fat. When the meat was cooked to the same internal temperature, oven roasts required two to three times longer to reach the desired end point than those cooked in fat. In general, as the internal temperature of the meat increased, the average cooking time and cooking losses increased significantly.

For a given muscle, shear values and tenderness scores were approximately the same regardless of internal temperature. Average tenderness scores for roasts cooked in fat at 100° C were slightly lower than scores for oven roasts or those cooked in deep fat at 110° C. Shear values usually were a little lower for oven roasts than for those cooked in fat.

For oven roasts and those cooked in deep fat at 100° C juiciness scores and press fluid yields usually decreased significantly as the internal temperature of the roasts increased. For roasts cooked in deep fat at 110° C, there were fewer differences in juiciness attributable to internal temperature. Meat cooked in the oven and in deep fat at 100° C was juicier than meat cooked in fat at 110° C. Generally, correlation coefficients for tenderness scores vs shear values and juiciness scores vs press fluid yields were not significant.

Acknowledgments

Appreciation is expressed to Dr. R. L. Merkel, Department of Animal Husbandry, for assistance in dissecting the muscles from the long hindquarters, and to Dr. H. C. Fryer, Department of Statistics, for advice in designing the experiments and analyses of the data.

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Tooling Up for Low Dose Irradiation Processing of Fresh Foods[a]

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(Manuscript received September 2, 1959)

Present day marketing of fresh foods has become more and more complex because centers of consumption are increasingly removed from centers of production. Maintenance of harvest-fresh quality during transit, distribution, and on the retailer's shelf has thus become a problem of growing importance.

Electron and gamma ray irradiation with doses in the 100,000 to 300,000 rad[b] range has been shown to retard the growth of spoilage organisms such as bacteria, and fungi for appreciable periods of time *(3, 15)*. Objectionable radiation side effects, such as flavor change and alteration of texture and color, are generally small and often undetectable in these dose ranges *(7, 12)*. Hence, low dose radiation processing has been extensively considered as a useful tool for extending shelf-life of fresh foods, particularly when used in conjunction with refrigerated storage and other auxiliary methods of preservation *(4, 9, 10, 11)*.

With this knowledge in mind, about 2 years ago a program was initiated to bring shelf life extension by low dose electron beam irradiation to the point of a usable commercial process for certain promising

[a] Presented at the Nineteenth Annual Meeting of the Institute of Food Technologists, Philadelphia, Pennsylvania, May 19, 1959.

[b] 1 rad = 100 ergs of absolute energy per gram of density one material.

foods available in abundance on the West Coast. Commercial use of low dose irradiation requires, in addition to the radiation preservation itself, successful control of factors such as handling the food between harvest and irradiation, packaging, dose measurement, dose distribution, efficiency of beam utilization, handling during and after irradiation, auxiliary methods of shelf life extension, etc. Only when these variables have been worked out for a given food should the next step be taken—the irradiation of large enough quantities of the food to permit distribution and market studies through existing commercial channels. Once this second step has been successfully concluded, a pilot operation can be initiated with an eventual scale-up to actual commercial processing. In view of the appreciable outlay necessary for an adequate radiation facility, we have utilized existing service facilities with an electron linear accelerator as a convenient way to carry out irradiation on a pilot plant scale, thus postponing the need for the purchase of radiation sources until it has been proven that a radiation-preservation process can be successfully scaled up to the commercial level.

Using the above approach, results can now be reported for several fresh foods. The general technique can be illustrated with two typical foods; namely, fresh strawberries and fresh ocean fish, a description of the irradiation service facilities used for this work, and a projected cost estimate considered to be representative for commercial low dose radiation processing of foods such as fresh fish.

MATERIALS AND METHODS

Strawberries. The berries used were of the Shasta variety. They were harvested, chilled to reduce enzyme activity, packaged in commercial baskets and crates, transported refrigerated to the radiation facility at Walnut Creek, California, irradiated the same day as harvested, and then transported to Davis, California for observation and evaluation. To enhance the severity of the experiment, a few berries inoculated with the Botrytis organism, were deliberately placed in each basket (control and irradiated) prior to the treatment.

Fish. Raw fillets or steaks (commercial cuts, 0.5 to 1.2 in thick) were obtained as fresh as possible from local San Francisco fish dealers. They were then packaged in plastic films (polyethylene laminate and polyester) and heat sealed. Subsequently, the packages were covered with crushed ice and transported to the irradiation facility at Walnut Creek, California. Due to the low total dose and the high dose-rate of the accelerator, the irradiation time was so short that no detectable warm-up of the samples was noted during transport into and out of the irradiation area. Hence, no additional cooling was provided during irradiation. After irradiation, the packages were transported in ice back to the laboratory in San Francisco where they were subsequently stored at temperatures ranging from about 35° to 42° F for observation and evaluation. The samples were kept either until they were all used or until they became unfit for consumption. The quality of the fish was evaluated bacteriologically, chemically, and organoleptically. The chemical tests included the determination of total volatile and trimethylamine nitrogen and of the volatile reducing substances (VRS), which are responsible for or related to the odorous constituents. The organoleptic evaluation included general appearance (color), odor, texture and taste of the unseasoned product after steam cooking.

Radiation source. The characteristics of the traveling wave electron linear accelerator used in our work are outlined below in the text in conjunction with the description of the service facility. A dose of 4 x 10^5 rad per pulse is available from the linear accelerator. However, considerations of product geometry and uniformity of depth dose distribution generally make it inconvenient to utilize more than a portion of the total pulse intensity. Preferred technique with fresh product, therefore, is to apply the required dose by multiple pulses. Pulse length is 10 μ seconds. Pulse repetition rate is variable from single pulses to 180 pulses per sec.

Dosimetry measurements were made using Cobalt glass color change as measured on a spectrometer. Calibration of the Cobalt glass was made against a calorimeter *(14)*.

RESULTS AND DISCUSSION

Strawberries and other fruits. Mold damage caused by *Botrytis cinerea* occurs widely on fresh fruits and seriously limits the storage time of strawberries after picking. Figure 1 shows the effect of 8 Mev electron irradiation on the subsequent growth of this mold in pure culture at 36 to 38° F *(8)*. Figure 2 shows the actual appearance of the mold 11 days after irradiation. Both figures indicate that at a holding temperature prevailing under normal refrigeration, the growth of this mold is very appreciably retarded for a period of up to 16 days by a dose of 200,000 rad; the retardation at the 400,000 and 800,000 rad level extends well over 20 days and is somewhat more pronounced than in the case of the 200,000 rad dose. Figure 3 shows a representative experiment with Shasta strawberries irradiated at 200,000 rad. The picture represents the appearance of control and irradiated berries after 2 days holding at 68° F, and the difference between the heavily molded, unirradiated control and the completely unaltered irradiated sample is very apparent. Experience to date indicates that a refrigerated shelf-life extension of 10 days or better can be expected by using this technique of low dose irradiation treatment. This is predicated on the use of present handling techniques, such as cooling directly after picking and refrigerated distribution, methods which tend to minimize enzymatic action and therefore maintain over-all qualities of the berries for a longer period of time. This is one of many examples where the proper handling and holding techniques prior to, during, and after irradiation are essential adjuncts to the radiation preservation in

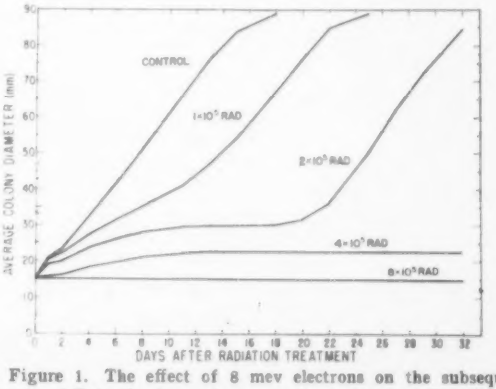

Figure 1. The effect of 8 mev electrons on the subsequent growth of Botrytis cinerea in pure culture at 36–38° F.

order to obtain a successful process and a satisfactory end product.

As described below, irradiation with a high energy electron beam capable of penetrating the total object rather than only the area at which bacteria or mold decay is going on does not seriously influence the over-all quality of the irradiated food—at least, at the dose levels used. Thus, it appears that processing with a high energy electron beam may eliminate much of the cumbersome handling detail which is necessary to expose multiple, randomly distributed infected areas when a low energy electron beam of limited penetration is used *(6)*.

Table 1 lists examples of fruits where mold and fungus damage has been successfulyl controlled with electron doses up to 300,000 rad. Depending on normal commercial handling technique, storage after irradiation was either refrigerated or at room temperature, and extension of shelf life was determined at either of these two temperature ranges. In all instances, undesirable changes in flavor, appearance or color were minimal or non-existent, provided that proper handling and holding techniques were utilized. Another aspect of considerable importance is the selection of the proper variety of fruit when considering shelf life extension by low dose electron beam irradiation. This seems to be particularly important in cherries, grapes, peaches, and strawberries.

Fresh ocean fish. Figure 4 represents a typical experiment with salmon steaks irradiated at 150,000 rad and sole fillets irradiated at 250,000 rad. In this instance the quality of the fish was judged by the determination of volatile reducing substances *(1)* with a value of 15 representing the breaking point between acceptable and spoiled. With proper care in selecting the fresh fish, and with proper handling techniques, it can be seen that the irradiation will extend the shelf life of both the salmon steaks and sole fillets to about 20 days at a storage temperature of 42° F. Refrigerated shelf life extension for other fish species such as

TABLE 1

Retardation of mold and fungus damage in fruits by low-dose (<300,000 rad) electron-beam irradiation

Product	Type of spoilage
Fresh Fruit	
Cherries[1]	Sclerotinia
Grapefruit	Blue Mold (P. Digitatum; P. Italcum)
Lemon	Blue Mold (P. Digitatum; P. Italcum)
Grapes[1]	Slip Skin (Botrytis)
Peaches[1]	Brown Rot
Pineapple	Brown Rot; Black Rot
Strawberries[1]	Gray Mold (Botrytis); Leak (R. Nigricans)
Dried Fruit	
Apricots	Misc. "Rots" (Molds; Fungi)
Dates	Misc. "Rots" (Molds; Fungi)
Prunes	Misc. "Rots" (Molds; Fungi)
Raisins	Misc. "Rots" (Molds; Fungi)

[1] Radiation resistance varies with variety.

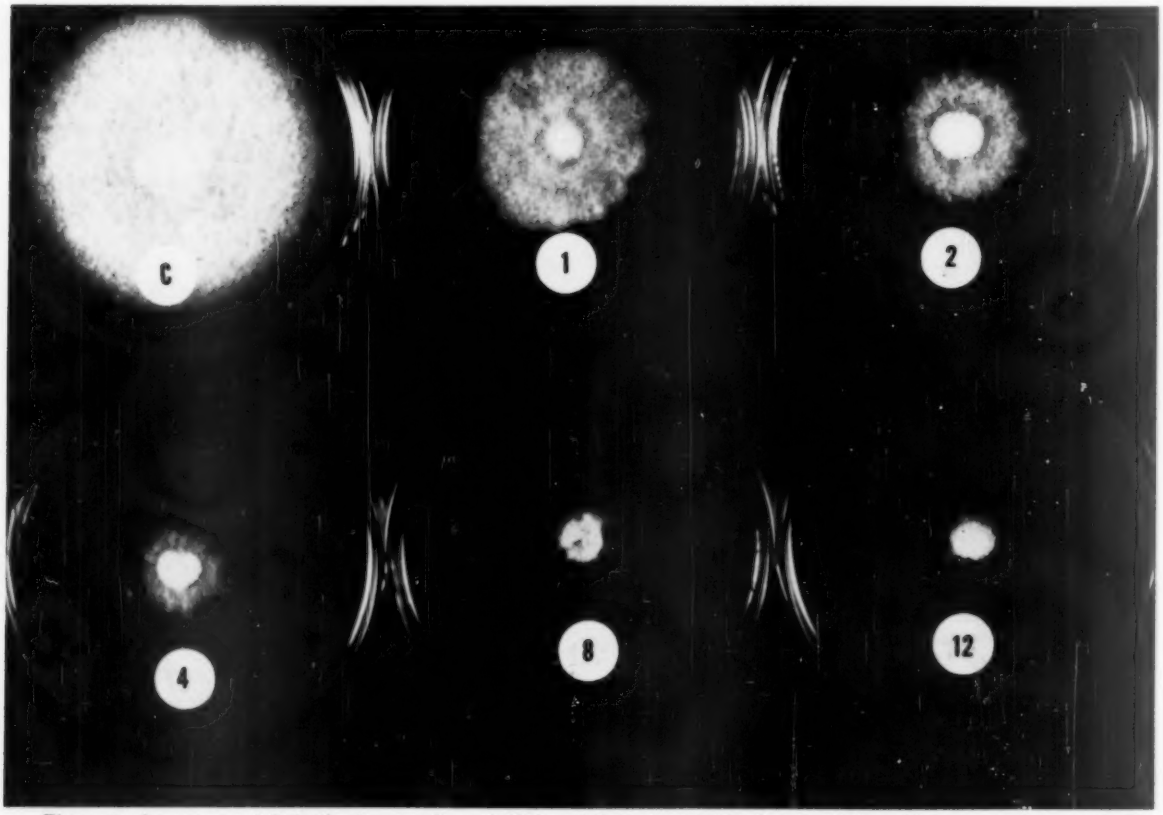

Figure 2. Appearance of Botrytis cinerea cultures held for 11 days at 36–38° F after irradiation with 8 mev electrons at 100,000 (1), 200,000 (2), 400,000 (4), 800,000 (8), and 1,200,000 (12) rad. C = unirradiated control.

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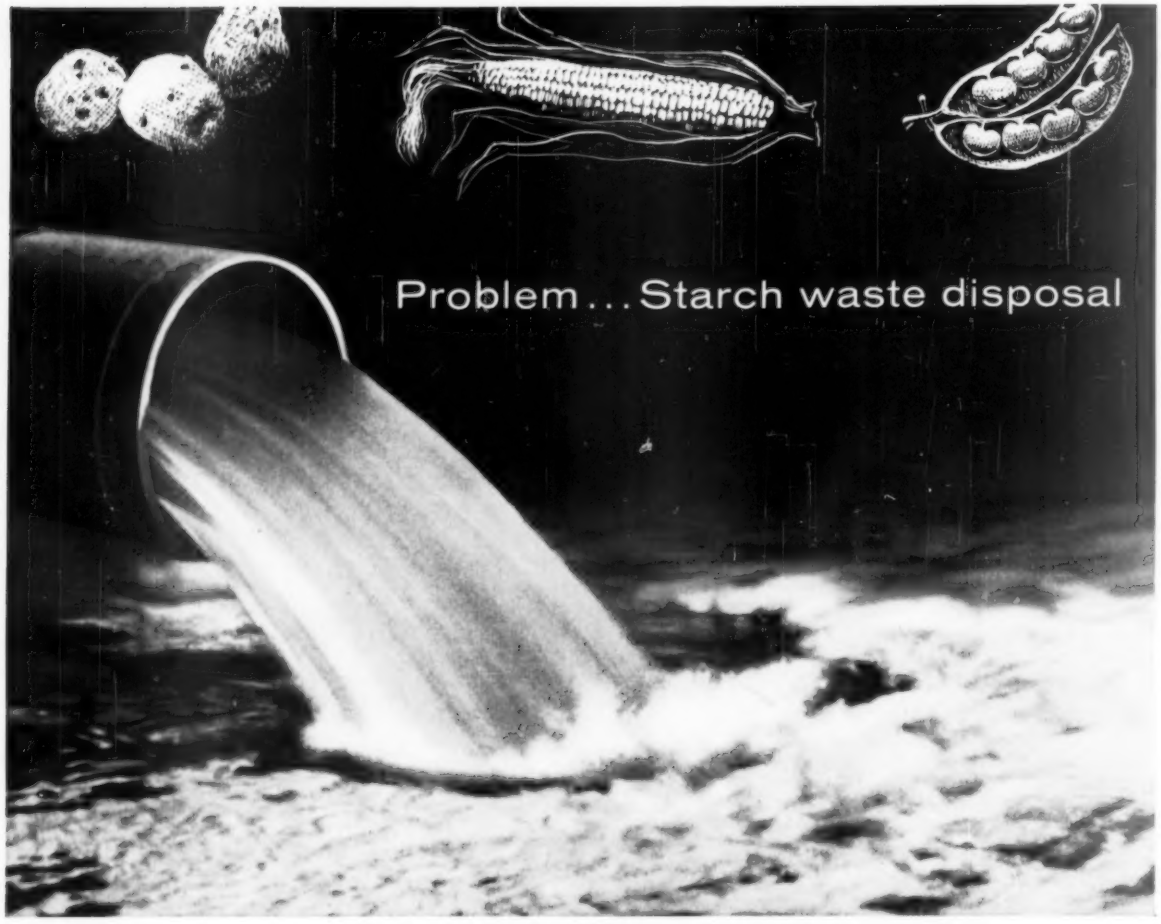

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Chemicals for Industry

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halibut and rock fish as well as shell fish such as cooked crab meat and shrimp could be obtained for similar periods of time by irradiation with doses of the order of 250,000 rad *(2)*.

Packaging. Packaging for low dose radiation processing of fresh foods is another factor that needs close attention to and understanding of the prevailing problems in order to arrive at a successful end product. Selecting the proper packaging material will depend upon the character of the food as well as upon the storage condition after irradiation. Above all, the packaging material must protect the product against reinfestation after irradiation well in excess of the maximum expected storage period prior to consumption. In addition, its mechanical construction must be such that it will withstand the additional holding time in distribution and on the retailer's shelf made possible by the radiation treatment. Furthermore, none of the essential physical properties of the packaging material such as tensile strength, composition, vapor-moisture permeability, etc., must be changed due to the fact that package and contents have been irradiated. Finally, it is important not to overlook the fact that fresh fruits, for instance must be packaged in such a way that gas exchange to and from the fruit after irradiation is not impaired. In contrast, other foods such as fresh fish, or cooked shell fish, or dried fruits should be packaged in materials that have considerable resistance against vapor or moisture transmission.

Radiation service facility. Figure 5 is a diagram of the layout of the service facility that was used for this work. The radiation source is a traveling wave electron linear accelerator.[c] The output of the accelerator can be varied over quite wide limits with optimum performance obtained at 8 mev. All experiments were performed at this energy level. Typical utility requirements are 480 v service 75 kva, with cooling provided by 13 gpm water and 1000 cu ft per min of air. Most of the air is used to ventilate the radiation chamber to remove ozone and nitrous oxides formed from air during the irradiation. Shielding requirements are 4 ft of regular concrete in the direction of low occupancy areas and 7 ft in the direction of the operator. During operation the food is placed on the conveyor and brought into the radiation chamber through a labyrinth. Once in the radiation chamber, the food is conveyed into and through the electron beam and then brought out again on the conveyor through the labyrinth for unloading. One technician is required for the operation of the accelerator and one attendant for loading and unloading the conveyor.

[c] Model Mark 1-F2 linear accelerator, manufactured by Applied Radiation Corporation, Walnut Creek, California.

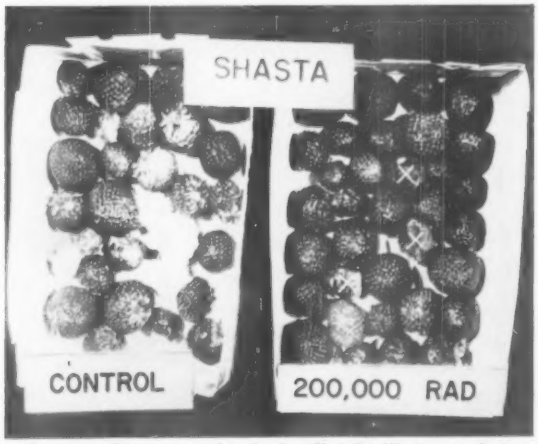


Figure 3. Shasta strawberries irradiated with 8 mev electrons at 200,000 rad. Appearance after two days at 68° F. "X" in the irradiated sample indicates rotten berries purposely introduced to increase the severity of the experiment.

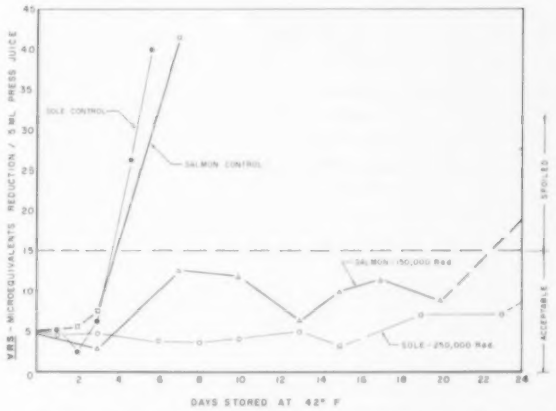


Figure 4. Shelf life extension of pre-packaged sole fillets and salmon steaks irradiated with 8 mev electrons.

The accelerator used has a beam diffuser. Consequently, the dose distribution is uniform over an 8 in wide package in the lateral direction while total dose and uniformity of distribution in the forward direction is controlled by adjustment of the conveyor speed.

The power output of the accelerator is such that for pilot studies at a 250,000 rad dose level, one ton of food per hr could be treated, provided that a 50% utilization can be achieved. With a solid, rectangular product, such as fish fillets and steaks which can be spaced to utilize all the available conveyor space, a 50% beam utilization is readily possible. Unevenly shaped objects such as strawberries and other fruits require much looser packaging with the voids between individual places representing loss of processing space. Efficiency of beam utilization in such instances has to be determined individually for each item, and in some cases will be considerably below the 50% utilization figure possible for solid and densely spaced materials.

Expressed differently, at the energy and power output levels of the accelerator, a 1 lb package of fillet of sole would be exposed to the irradiation for 1.8 sec to absorb the 250,000 rad dose necessary for a 20 day refrigerated shelf-life.

Spoilage organisms such as bacteria and fungi are generally located on the surface or sub-surface areas of fresh foods. Hence, it appears at first glance that

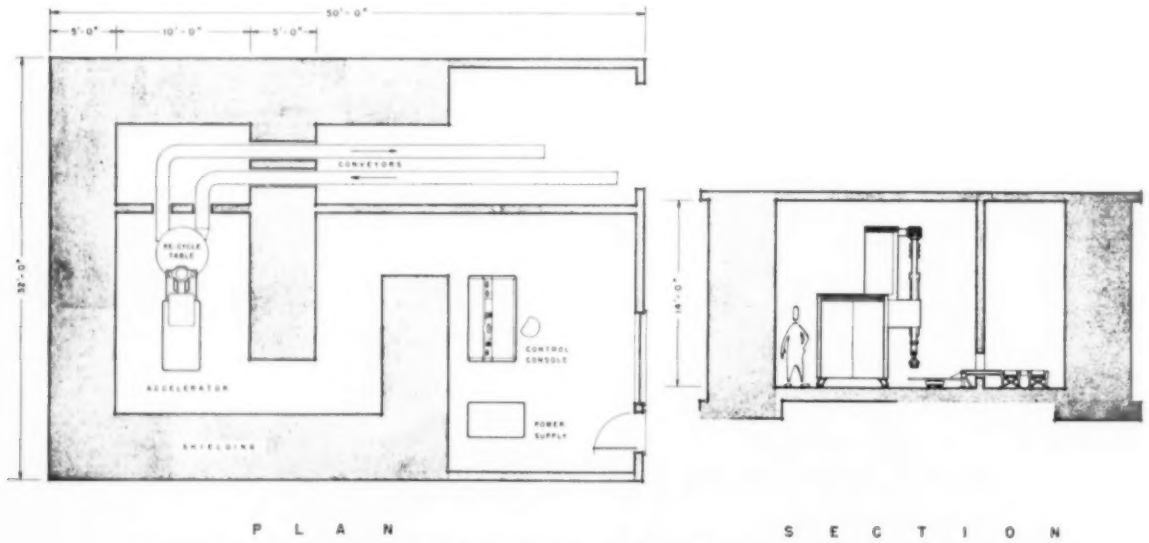
8 mev is an unnecessarily high energy for this type of electron beam processing. However, it is well known that multiple handling increases the damage to fresh foods materially. In addition, it is highly desirable for economic reasons to reduce the number of operations in food processing to an absolute minimum. Irradiation with a high energy electron beam not only often permits the simultaneous penetration of several layers of product, but also makes it possible to utilize a variety of presently used commercial packages. Furthermore, it eliminates additional handling to assure the exposure of all surfaces of the food to radiation, since the high energy electron beam penetrates the product throughout. In contrast, one has to consider the additional damage that may be caused to the food by the fact that the radiation penetrates throughout rather than to a limited surface area only. At the dose levels used in this work, we found that the radiation damage to the non-contaminated interior part of fresh fish, dried fruits, as well as cherries, grapefruit, grapes, peaches and strawberries was minimal or non-existent and, therefore, was not a deterrent to the use of a high energy electron beam.

COMMERCIAL POTENTIAL AND COSTS

Initial commercial uses of low-dose radiation processes, apart from applicability, will largely be determined by the dollar value of the product. The retail price of a given fresh food should be high enough to offset the additional cost due to radiation processing irrespective of quality improvement in the treated product. In these terms strawberries and fresh ocean fish are attractive because of their comparatively high retail price. 1957 California strawberry gross sales were $35,000,000 at wholesale, with losses in some cases running to 20 to 30% due to spoilage. The 1957 West Coast catch of flounders, halibut, salmon and related varieties had a value of about $30,000,000 at wholesale. In this instance, in addition to minimizing spoilage which is in itself often in excess of 15%, the extension of shelf life by irradiation will make it possible to open new markets in the inland areas heretofore inaccessible for fresh ocean fish due to the limited shelf life of this commodity.

Table 2 shows a projected cost calculation for commercial low dose radiation processing of fresh food. The figures are based on operating costs for a service facility and scaled up to commercial processing. The operating costs for the linear accelerator facility include return on invested capital, 10 year depreciation, utilities, direct labor, maintenance, and overhead. The latter includes taxes and insurance. Also included is a liberal figure representing the write-off for research and development costs. The one item missing in this calculation is the cost of building alterations to house the irradiation facility. This cost is very hard to estimate since it will vary greatly from case to case. The costs per hour are calculated for a 6000 hr triple shift year and a 2000 hr single shift year. In a single shift operation hourly costs for return on invested capital and for depreciation increase, while labor, maintenance, utilities, overhead and R & D costs remain constant. Thus, any operation at less than 3 shifts per day would result in increased operating costs per hour.

Postulating a 50% beam utilization which can be obtained with commodities such as fish fillets and steaks, a throughput of 4.6 tons per hr at 250,000 rads would be possible. The over-all additional cost due to radiation processing would, therefore, amount to 2.8 mils per lb under such favorable processing conditions. Beam utilization of less than 50% would, of course, increase the cost accordingly. With bulky and



P L A N S E C T I O N

Figure 5. Layout of irradiation service facility equipped with high energy electron linear accelerator.

TABLE 2

Projected cost calculations for commercial, low-dose radiation-processing of foods with high energy electrons from a linear accelerator. Basis: Operations cost per hour

Capital cost, 8 mev, 5 kw Linac,[1] installed[2]	$170,000
Capacity, at 250,000 rad and 50% beam efficiency	9,200 ℔/hour

	Hourly cost of operation	
	For 6000 hr triple shift year	For 2000 hr single shift year
Operations costs		
Return on invested capital[3]	$ 4.25	$12.75
Depreciation—10 years	2.64	7.92
Direct labor—operator, helper	5.00	5.00
Utilities	0.50	0.50
Maintenance	8.80	8.80
Overhead, taxes, insurance	2.50	2.50
R + D costs[4]	2.30	2.30
	$25.99	$39.77
Cost per 0.25 Megarad-Pound		
Linac[1]		
50% beam utilization	$ 0.0028	$0.0043
25% beam utilization	0.0056	0.0086
Cobalt-60 (335,000 curies; $0.34/curie)[5]		
50% beam utilization	0.0150	.....
25% beam utilization	0.0300	.....
Cesium-137 (1,220,000 curies; $0.60/curie)[5]		
50% beam utilization	0.0280	.....
25% beam utilization	0.0560	.....

[1] Mark 1-F5 Linear Accelerator, Applied Radiation Corp. Walnut Creek, Calif.

[2] Cost for building alterations *excluded*.

[3] Earnings at 15% per annum after taxes on capital invested during 10-year depreciation period.

[4] One mil per megarad pound at 50% beam efficiency.

[5] Stockman, C. H., and Bauman, R. G. *(13)*.

non-uniform items such as strawberries, beam utilization may be as low as 20 to 30%. In such instances, the cost per pound would be of the order of 0.5 cent. For comparison purposes, processing costs with isotope sources such as Cobalt 60 and Cesium 137 have been included. These costs are based on the study by Stockman and Bauman *(13)* in which the authors used liberal assumptions about the future cost of the isotopes. It will be noted that radiation-processing with gamma rays from such isotope sources would be considerably more expensive than with a high energy electron beam from a linear accelerator.

SUMMARY

Several aspects of a program to bring shelf-life extension by low-dose irradiation with a high energy electron beam from a linear accelerator to the point of a commercial process for certain fresh foods available in abundance on the West Coast are described. Progress to date is illustrated by application to fresh strawberries and fresh ocean fish, taking into account additional process variables that have to be controlled to make shelf-life extension by low-dose irradiation a success.

A radiation facility with an 8 mev linear accelerator adaptable to pilot plant processing of fresh foods is also described.

Analysis of cost calculations based on operation of a service facility indicates that costs of a commercial operation will be of the order of 0.5 cents per 0.25 megarad pound for fresh foods of irregular shape, such as strawberries. Uniform density throughout the package and rectangular package dimensions as in the case of fresh fish fillets and steaks, increase efficiency of beam utilization with a corresponding decrease in cost.

Acknowledgment

The work on strawberries was done in conjunction with Dr. E. Maxie, Department of Pomology, and Dr. K. E. Nelson, Department of Viticulture, University of California, Davis, California. The work on fish was done in conjunction with Drs. L. Farber and P. Lerke, Fisheries Research Laboratory, George Williams Hooper Foundation, University of California, San Francisco, California. Both studies are part of a broad program to investigate the shelf-life extension of fresh produce and fresh ocean fish by low-dose, high energy electron beam irradiation.

The authors extend their sincere thanks to Drs. Maxie, Nelson, Farber and Lerke for their help and cooperation in the execution of these phases of our work.

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Vanilla Extract. II.

Stability of Lead Test Solution

William J. Considine and Bernard Pearl

Felton Chemical Company, Inc., Brooklyn 37, New York

(Manuscript received November 9, 1959)

THE OFFICIAL METHOD *(2)* for determining the lead number of vanilla extracts calls for a blank determination. In a laboratory which runs many such determinations this procedure is burdensome. A blank determination is certainly the preferred method for determining lead in the test solution, but if the lead concentration of the solution does not vary over a period of time, then only one blank will suffice for a whole series of lead number determinations.

TABLE 1

Age (days)	g Pb/100 ml of solution	
	I	II
0	0.223	0.214
	0.223	0.214
2	0.223	0.214
	0.223	0.214
3	0.223	0.214
	0.224	0.214
7	0.223	0.214
	0.223	0.214
10	0.223	0.213
	0.223	0.214

Using an ethylenediaminetetraacetic acid (EDTA) titration method *(1)* for the determination of the lead, triplicate blank determinations, according to the official method *(2)*, were run on a lead test solution. The freshly prepared solution had a lead concentration of 0.229, 0.229, and 0.230 g/100 ml. After 10 days storage the lead concentration of the solution was 0.229, 0.229, and 0.229 g/100 ml.

Table 1 records the results of a study of two other lead test solutions.

Solution (I) was stored in an amber glass bottle and solution (II) in a transparent glass bottle. Blank determinations *(2)* were run in duplicate and lead was determined with EDTA *(1)*.

Data in Table 1 demonstrate that lead test solutions can be stored for at least one week without any significant fall in titer.

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IN THIS ISSUE—

TECHNICAL ARTICLES IN BRIEF

Storage behavior *Frozen peas*

Time-temperature tolerance of frozen foods. XXI. Frozen peas. Mildred M. Boggs, W. C. Dietrich, Marvel-Dare Nutting, R. L. Olson, F. E. Lindquist, G. S. Bohart, H. J. Neumann, and H. J. Morris.

Experiments were carried out with 4 varieties of frozen peas packed in retail packages in 8 processing plants in 4 major growing areas during the seasons of 1952 to 1957. Changes in color, flavor, chlorophyll, reduced ascorbic acid content, and reflectance data obtained by the Hunter Color and Color-Difference Meter (HCM) were determined as a function of temperature in the range of −10° to +40° F. Effects of regular and irregular fluctuations in product temperature were measured and the question whether the order of occurrence of different temperatures has any influence was investigated. Off-color was detected by trained judges in frozen peas that had been held for approximately 7 months at 0° F and off-flavor, after approximately 10 months at the same temperature. All measurements, except ascorbic acid, showed deterioration rates approximately doubled for each 5° F increase in temperature between 0° and 25° F. Ascorbic acid loss rates more than doubled under the same conditions. The two-fold change in deterioration rates per 5° F applied up to 30° F in the case of chlorophyll, HCM "a", and flavor data, but not to color data. Much less than the two-fold change per 5° F occurred between 30° and 40° F, except for flavor which followed the 0° to 30° F pattern. Chlorophyll and HCM "a" *differences* for 2 samples of the same lot of peas were good indices of color deterioration and reasonably good indices of flavor deterioration. Fourteen lots of peas held at 20° F varied almost four-fold in their rates of chlorophyll loss. Industry panels found that color of all 6 lots of peas they evaluated had reached a stage which they characterized as "acceptable, but not high quality" in one or two months at 20° F. Chlorophyll and HCM "a" results correlated reasonably well with industry panel scores; ascorbic acid content of the peas and panel scores were not closely associated when all lots of peas were considered. Changing the order of occurrence of two different steady temperatures did not significantly affect deterioration of frozen peas. Fluctuation of temperature *per se* had little or no effect on deterioration of peas held under regular, 24-hour, sine-wave cycles varying from −5° to 5°, −10° to 10°, and 0° to 20° F and under 3 slower, irregular temperature patterns with maximum temperatures of 10°, 20° and 30° F. (See page 181.)

Tenderization *Beef carcasses*

A method for the rapid tenderization of beef carcasses. G. D. Wilson, P. D. Brown, Carol Pohl, C. Edith Weir, and W. R. Chesbro.

In this study five beef carcasses were employed to determine the desirability of aging meat in the wholesale cut at elevated temperatures to increase tenderness. Two or 3 hours prior to slaughter 5 to 10 g of oxytetracyline were given intraperitoneally or intramuscularly in 50 to 100 ml of solution. The injection of the antibiotic in several locations in the tail was found convenient and resulted in tissue levels of 0.5 to 1.0 ppm which was usually sufficient to control bacterial growth during aging. One hindquarter and rib cut of each carcass was aged for 24 hours at 110° F and the corresponding cuts from the remaining side were aged for 2 weeks at 35° F. The high temperature aging schedule resulted in a significant increase in tenderness in steaks removed from the short loin (*longissimus dorsi*). Three muscles of the round and the *longissimus dorsi* of the rib were used to compare the two aging procedures. Taste panel results showed a slightly greater tenderization effect of the 35° F aging procedure. Slight flavor changes were noted in some of the steaks from sides aged at 110° F. The limited number of carcasses in this study does not permit definite conclusions regarding the commercial application of the accelerated aging procedure. The data show, however, that significant tenderization can be achieved in beef by holding the carcasses at 110° F for 24 hours after slaughter. (See page 186.)

Ripening *Effect on vitamins of beef*

The effect of ripening on the thiamine, riboflavin, and niacin content of beef from grain-finished and grass-finished steers. Bernadine Meyer, Juanita Thomas, and Ruth Buckley.

Purpose of the work reported was to test effects of ripening on the thiamine, riboflavin, and niacin content of beef muscle tissue from grain-finished and grass-finished steers. It was part of a study of the effects of ripening on the quality of grain-finished and grass-finished beef. The amount of thiamine, riboflavin, and niacin in the *longissimus dorsi* and *semimembranosus* muscles of grain-finished and grass-finished beef from genetically similar steers was determined on the day of slaughter, and at 7, 21, and 42 days of ripening. Values are reported on a moist and on a fat-free dry basis. No significant differences in the raw tissue content of these 3 vitamins were associated with the 2 feeding regimes. Both grain-finished and grass-finished beef would seem to be equally satisfactory sources of thiamine, riboflavin and niacin. There was a slight, but highly significant increase ($P = 0.001$) in thiamine content at 21 days of aging. Aging up to 42 days had no significant effect on the amount of riboflavin present. The niacin content of the beef decreased about 25 to 30% between the day of slaughter and the 7th day of aging. This decrease was highly significant ($P = 0.001$). Further significant losses of 5.6 and 6.9% of niacin were found by the 21st and 42nd day of ripening respectively. The *semimembranosus* muscle was found to contain significantly more ($P = 0.001$) thiamine and riboflavin than the *longissimus dorsi* muscle.

(Continued on page 24 following Technical Section)

IFT News

1960 Award Winners

The Institute of Food Technologists Award Juries recently announced 1960 winners of the Food Technology Industrial Achievement Award, The Babcock-Hart Award, and the Nicholas Appert Award.

FOOD TECHNOLOGY INDUSTRIAL ACHIEVEMENT AWARD

A large bronze plaque will be presented each of the 1960 joint winners of the Food Technology Industrial Achievement Award: MERCK & COMPANY, and the AMERICAN MEAT INSTITUTE FOUNDATION. To qualify for the award a contribution must be "an outstanding food process representing a significant advance in the application of Food Technology to food production." These organizations were cited for their work in the employment of *Pediococcus cerevisiae* as a starter culture for the controlled fermentation of sausage.

Judged to have made major contributions to the achievement are Mr. R. P. Dudley of Merck & Co., and Dr. R. H. Deibel, Dr. C. F. Niven, and C. D. Wilson of the American Meat Institute Foundation. At the Annual Meeting in San Francisco, each will receive an engrossed plaque for his part in making the process a success.

NICHOLAS APPERT AWARD

Being honored for pre-eminence in and contributions to the field of Food Technology is 1960 Nicholas Appert Award recipient DR. ERNEST H. WIEGAND. Dr. Wiegand's work best met the Institute requisite above of those nominated this year. He will receive an honorarium of $1000 donated by the IFT, and a Bronze Medal furnished by the Chicago Section, at the Awards Banquet, Annual Meeting of IFT, in San Francisco. Dr. Wiegand, long associated with food research at Oregon State College, is widely known in IFT and has been associated with its history from the beginning.

BABCOCK-HART AWARD

For technological developments having contributed directly to improve public health through some aspect of nutrition or more nutritious food, DR. ARNOLD H. JOHNSON is named the 1960 Babcock-Hart Award winner. As set forth by the donor, The Nutrition Foundation, the recipient of the $1000 and engrossed plaque must have distinguished himself in the field of food technology either through technological developments or scientific contributions which lead directly to technological developments. These developments must have, in actual practice, influenced the nutritional well-being of the public. The Award is made only for such contributions, rather than for contributions in clinical nutrition and fundamental scientific studies. Presentation will be made in San Francisco at the annual Awards Banquet, Twentieth Annual Meeting. Dr. Johnson, National Dairy Products Corp., Oakdale, Long Island, N. Y. has made many important contributions in the area covered by the Babcock-Hart Award.

REGIONAL NEWS

NORTHEAST

Mr. William F. Camp of the Plax Corp., Hartford, Conn., Technical Service Department was the speaker at the January meeting. The meeting was well attended considering the usual snow storm at this time of year.

Mr. Camp spoke on the present and future uses of oriented polystyrene in food packaging. The "Plasti-Loc" package using the new process of cold folding polystyrene sheeting is a unique process with very interesting possibilities for packaging many types of food products. Heat shrinkable polystyrene film has many outstanding physical properties which make it suitable for many areas of packaging in the food and other industries.

For our February meeting, Mr. Donald Hall, of the Instrument Development Laboratories, Inc., Attleboro, Mass. was our guest speaker. His subject covered the principles and use of various instruments for the color measurement of foods. Colorimeters, spectrophotometers, color difference meters and reflectance meters were discussed. These instruments and associated techniques are invaluable for quality control and food research.

—Donald E. Westcott

INDIANA

The Indiana Section is planning its annual Ladies' Night meeting, Tuesday, May 10, 1960.

The Social Hour will begin at 5:45 p.m. C.D.T. and dinner will be served at 6:30. An after-dinner program that is light but not dry will be served up by Mr. Robert Spitzer of the Taylor Wine Company. Mr. Spitzer will show pictures of wine processing operations. An interesting portion of the program will be a tasting session of various wines. Section members and their wives are looking forward to becoming active in the area of sensory evaluation of wine.

The Indiana Section completes the 1959–60 series of meetings with this program. Noble Tarvin, our retiring chairman, will turn over the gavel to Fred Dellwo, the chairman for the 1960–1961 series. The members of the Indiana Section are thankful for the job well done by Mr. Tarvin and pledge their support to Mr. Dellwo.

(Continued on page 24 following Technical Section)

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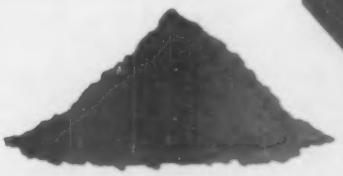

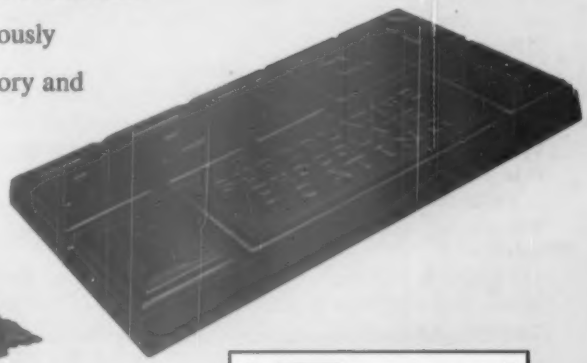

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(Continued from page 20 preceding Technical Section)

BRITISH COLUMBIA

Dr. James G. Foulks, Professor and Head, Department of Pharmacology, University of B. C. presented his thoughts on "Why the Ban on Nuclear Weapons Testing Should be Maintained" to the B. C. Food Technologists at their February dinner meeting.

Dr. Foulks said that, according to published data, the Strontium 90 content of milk has been increasing, on the average, at the rate of 2½ units, although in some areas monthly values had reached as high as 45 S. U. The Atomic Energy Commission has stated that the maximum permissible concentration of Strontium 90 in milk is 100 "Strontium units." Dr. Foulks explained how Strontium 90 can be removed from milk by ion exchange, but pointed out that the replacement calcium would have to be from deposits which had not been exposed to Strontium 90.

Quoting figures, the speaker expressed concern over reports of tests on raw wheat, where during the years 1957 and 1958, concentrations averaged 100 units or higher.

The controversy over the hazards of nuclear weapons testing stems from incomplete scientific knowledge of the hazards of radiation, particularly the question as to whether or not there is a "threshold" for induced mutations.

About sixty people attended the meeting, and included a number of visiting technologists from the Okanagan who were in the city for the Western Food Processors Annual meeting. Dr. H. W. Schultz, Head of the Department of Food and Dairy Technology, Oregon State College, was an honoured guest.

AK-SAR-BEN

"Food faddism is something all intelligent people are trying to combat," said Dr. Imri J. Hutchings, manager of food research for the H. J. Heinz Company, Pittsburgh, Pa. He spoke at a dinner meeting of the Omaha section of the Institute at the Hilltop House, February 25.

"People are paying thousands of dollars a ton for alfalfa in bottles," he commented. "Unfortunately, the body can take only so many vitamins and if you take five thousand times more than the needed amount, it is pure waste."

Folklore. Many of the fads grew out of folklore, but are fastening themselves on the public more and more.

"There is a definite effort on the part of professional food scientists to stem food faddism. It has no business in the area of food," Dr. Hutchings said.

A normal diet will give the average person the vitamins needed, he added.

Dr. Hutchings, IFT president elect, told the Ak-sar-ben section that America must take the lead in the world in providing better nutrition.

—*George Eisenberg*

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1960	
April 19-21	Research and Development Associates 14th Annual Meeting, Congress Hotel, Chicago, Illinois
May 15-19	**Twentieth Annual Meeting of the Institute of Food Technologists, Fairmont Hotel and Masonic Temple, San Francisco, California**
May 19 to May 25 or 29	**IFT Pacific Rim Conference, Princess Kaiulani Hotel, Honolulu, Hawaii**
June 6-9	National Confectioners Association Convention, and Confectionery Industries Exposition, Philadelphia, Pennsylvania
June 8-10	The 3rd Symposium on Gas Chromatography, Assembly Rooms, Edinburgh, Scotland
June 9-10	Third Annual Conference, Canadian Institute of Technology, Royal Alexandra Hotel, Winnipeg, Manitoba
June 13-September 2	Gordon Research Conferences, New London, New Hampshire
August 29-September 9	Second International Course on Lyophilization, Lyon, France
September 20-23	Pure Food Centenary, Royal Institution of Great Britain, London, England
1961	
May 7-11	**Twenty-first Annual Meeting of the Institute of Food Technologists, Hotel Statler, New York, New York**
1962	
June 10–14	**Twenty-second Annual Meeting of the Institute of Food Technologists, Fontainebleau Hotel, Eden Roc Hotel, Miami Beach, Florida**
1963	
May 19–23	**Twenty-third Annual Meeting of the Institute of Food Technologists, Pantlind Hotel, Civic Auditorium, Grand Rapids, Michigan**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

Technical Articles in Brief

(Continued from page 19 preceding Technical Section)

However, the niacin content of these two muscles was not significantly different. (See page 190.)

Tenderness *Cooked beef*

The effect of degree of doneness on the tenderness and juiciness of beef cooked in the oven and in deep fat. Rosemary Y. Visser, Dorothy L. Harrison, Grayce E. Goertz, Marilyn Bunyan, Marilyn McNelis Skelton, and David L. Mackintosh.

Tenderness of cooked meat is the total effect of composition of muscle, aging before cooking, heat coagulation of muscle fiber proteins, and partial hydrolysis of connective tissues. Three experiments were conducted in which tender and less tender beef muscles from paired U. S. Good long hindquarters were cooked to rare, medium-, and well-done by oven roasting, cooking in deep fat at 110° C, and cooking in deep fat at 100° C. Rate of heat penetration was slower in oven roasts than in roasts cooked in fat. In general, as the internal temperature of the meat increased, the average

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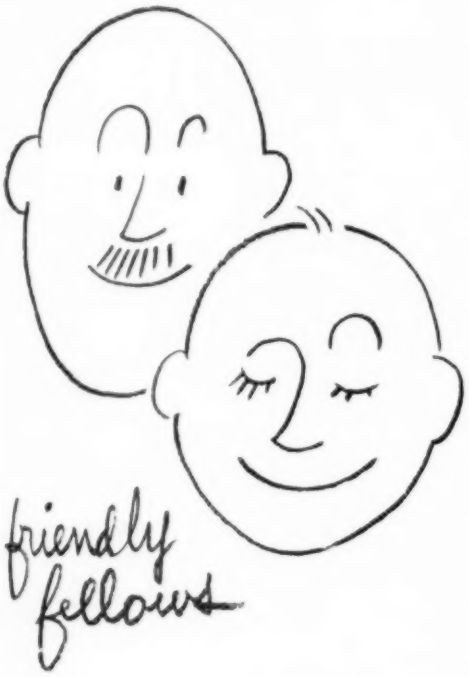

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cooking time and cooking losses increased significantly. For a given muscle, shear values and tenderness scores were approximately the same regardless of internal temperature. Average tenderness scores for roasts cooked in fat at 100° C were slightly lower than scores for oven roasts or those cooked in deep fat at 110° C. Shear values usually were a little lower for oven roasts than for those cooked in fat. For oven roasts and those cooked in deep fat at 100° C juiciness scores and press fluid yields usually decreased significantly as the internal temperature of the roasts increased. For roasts cooked in deep fat at 110° C, there were fewer differences in juiciness attributable to internal temperature. Meat cooked in the oven and in deep fat at 100° C was juicier than meat cooked in fat at 110° C. Generally, correlation coefficients for tenderness scores vs shear values and juiciness scores vs press fluid yields were not significant. (See page 193.)

Radiation preservation *Low-dose irradiation of fresh foods*

Tooling up for low-dose irradiation processing of fresh foods. Warren W. Eukel and Wolfgang Huber.

Present day marketing of fresh foods has become more and more complex because centers of consumption are increasingly removed from centers of production. Maintenance of harvest-fresh quality during transit, distribution, and on the retailer's shelf has thus become a problem of growing importance. Several aspects of a program to bring shelf-life extension by low-dose irradiation with a high energy electron beam from a linear accelerator to the point of a commercial process for certain fresh foods available in abundance on the West Coast are described. Progress to date is illustrated by application to fresh strawberries and fresh ocean fish, taking into account additional process variables that have to be controlled to make shelf-life extension by low-dose irradiation a success. A radiation facility with an 8 mev linear accelerator adaptable to pilot plant processing of fresh foods is also described. Analysis of cost calculations based on operation of the service facility indicates that costs of a commercial operation will be of the order of 0.5 cents per 0.25 megarad pound for fresh foods of irregular shape, such as strawberries. Uniform density throughout the package and rectangular package dimensions as in the case of fresh fish fillets and steaks, increase efficiency of beam utilization with a corresponding decrease in cost. (See page 198.)

Stability *Vanilla extract*

Vanilla extract. II. Stability of lead test solution. William J. Considine and Bernard Pearl.

The official method for determining the lead number of vanilla extracts calls for a blank determination. In a laboratory which runs many such determinations this procedure is burdensome. A blank determination is certainly the preferred method for determining lead in the test solution, but if the lead concentration of the solution does not vary over a period of time, then only one blank will suffice for a whole series of lead number determinations. The data obtained by these investigators demonstrate that lead test solutions can be stored for at least one week without any significant fall in titer. (See page 204.)

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ABSTRACTS

General Foods Research Center
Selected by H. A. Campbell

ANALYTICAL METHODS

Resin acids. Analysis by mass spectrometer (as methyl esters).

GENGE, C. A. (Hercules Powder Co., Wilmington, Del.). *Anal. Chem. 31*, 1750–3 (1959).

A mass spectrometer with a heated inlet system at 200° C. differentiates well among the similar structures of 13 resin acids (as methyl esters). An analysis is obtained in about 2 hrs. with a computer for solving 13 or more simultaneous equations.

Gas chromatographic separation of long-chain fatty acid methyl esters on polyvinyl acetate.

HORNSTEIN, I., ELLIOTT, L. E. AND CROWE, P. F. (U. S. Dept. of Agr., Beltsville, Md.). *Nature 184*, 1710–11 (1959).

Commercially available polyvinyl acetates were used to separate completely the methyl esters of stearic, oleic, linoleic and linolenic and arachidonic acids. Any trace impurities from the thermal degradation of polyvinyl acetate could be removed easily or compensated for in the spectrophotometric studies. Quantitative estn. of the fatty acid esters within ±5% could be made. In these expts. the partition medium consisted of 15% polyvinyl acetate 'Vinylite AYAC' on 'Chromosorb' 30–60 mesh. The helium flow rate was 83 ml./min. and the column and cell temp. was 205° C.

A collaborative test of Moore and Stein's resin-chromatography method for determining amino acids.

BENDER, A. E., PALGRAVE, J. A. AND DOELL, B. H. (Bovril Ltd., London, Engl.). *Analyst 84*, 526–36 (1959).

A collaborative assay of a mixt. of amino acids by Moore and Stein's technique was carried out in order to assess the accuracy of the methods as operated in different laboratories. The results show a high degree of consistency and agreement between the different laboratories. Nine amino acids, glycine, phenylalanine, lysine, valine, serine, threonine, aspartic acid, glutamic acid and tyrosine, were detd. with a mean recovery of 100 ±2%; the remaining 7 (alanine, leucine, isoleucine, arginine, histidine, proline and methionine), were detd. with an error of ±8%.

The diffusion analogy for solvent flow in paper.

RUOFF, A. L., ET AL. (Univ. of Utah, Salt Lake City). *Kolloid Z. 166*, 144–51 (1959).

The mathematics of diffusion have been found valid in the description of the flow of liquids in paper. Cases of linear and radial flow have been observed for several solvent-paper systems. The dependence of the diffusion coeff. on concn. for various systems has been detd. and these relations have been used in the numerical calcn. of the flow rate and concn. profiles. The agreement of theory and expt. is, in all cases, satisfactory, indicating the validity of the diffusion analogy.

BIOLOGICAL SCIENCES

Biochemistry

Growth inhibitory effect of oat hulls in rations for growing-finishing swine.

JENSEN, A. H., BECKER, D. E. AND TERRILL, S. W. (Illinois Agr. Exptl. Sta., Urbana). *J. Animal Sci. 18*, 1356–62 (1959).

Adding oat hulls at levels of 15 and 30% to hulled-oat rations or to corn-soybean oil meal rations significantly reduced the growth rate and feed efficiency of 100-lb. pigs. With 50-lb. pigs, 7 and 13% hulls markedly depressed performance. The results of the expts. suggest that the growth-inhibitory effect of oat hulls is mediated through the dilution of total digestible nutrient value of the ration, and lowered food intake.

Protein synthesis by isolated nucleoprotein particles.

WEBSTER, G. C. (Ohio State Univ., Columbus). *Arch. Biochem. Biophys. 85*, 159–70 (1959).

Do you know these facts about PAPAIN?

Papain is the dried and purified latex of the Carica Papaya. The papaya tree grows and is extensively cultivated in every tropical country, including Ceylon, South Africa, Hawaii, the East and West Indies and Puerto Rico.

Q. *What is papain's action?*

A. Papain is a very powerful and versatile proteolytic enzyme, with properties unrivalled by any other proteinase.

Q. *Who uses it?*

A. A long list of industries, ranging from breweries to the pharmaceutical industry. About 80% of all beer brewed in the U.S. is stabilized and chill-proofed with papain. Papain tenderizes inexpensive beef cuts, and is used for this purpose both by packers and restaurants. It clarifies vegetable juices and pre-digests cereals. It is even used in chewing gum to help digest food particles lodged between the teeth. Medicinally, papain is used in the treatment of a variety of gastric disturbances, infected and healing wounds, fistulas, psoriasis and sores, as well as for vaginal douches, sloughing ulcers and necrotic tissues, burn therapy, and as a cleanser with suppurating lesions. The cosmetic industry uses papain in a variety of skin creams and lotions and in toothpastes and tooth powders. Tanners use papain to digest coagulated albumens, making hides readily wettable and workable. The textile industry uses it to de-size various fabrics, including synthetics and woolens.

Q. *What are papain's chemistry and physical properties?*

A. Imported crude papain contains much foreign matter, both organic and inorganic. These impurities are removed by a special purification process developed by the Meer Research Laboratories, resulting in an extremely stable papain. Besides the powerful proteinases papain and chymopapain, Purified Papain contains small amounts of supplementary enzymes that actually increase the digestive activity of these principal enzymes. In appearance, it is a yellowish-white powder with characteristic odor and taste, easily soluble in water, glycerine and low hydroalcoholic solutions. It is the most thermostable enzyme known. As a powder, it remains stable for hours at 105°C; in solution, it is active at the usual cooking temperatures. Even at 90°C it retains a considerable action. However, in storage, commercial papain may lose up to 50% of its activity. This is not true of Meer Purified Papain, which doesn't lose measurable amounts of activity during the same storage period.

Q. *In what forms is papain available?*

A. Purified Papain "Meer 70", adjusted with lactose to proteolytic activity of NF VIII standard, is available powdered to Mesh 60, in 50 and 100 pound polyethylene lined fibre drums. The other Meer grades, also available powdered to Mesh 60, are similarly packaged. These include Purified Papain Standard "Meer S-100", Purified Papain "Meer T-130" and Purified Papain "Meer A-160".

Q. *What other botanicals does Meer process?*

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Isolated ribonucleoprotein particles from peas catalyze a net synthesis of "soluble" protein in the presence of adenosine triphosphate, guanosine triphosphate, manganese ions, phosphoglycerate, sol. polynucleotide, and a mixt. of the 18 amino acids and 2 amides usually found in protein. The protein thus formed exhibits more than one electrophoretic component, and has enzymic activity. If protein synthesis proceeds in the presence of C^{14}-labeled amino acids, the protein formed has a specific activity close to that of the free amino acids. The enzyme system is rather unstable. 29 references.

Metabolism and hormonal control of pectic substances.

ALBERSHEIM, P. AND BONNER, J. (California Inst. of Technol., Pasadena). *J. Biol. Chem. 234*, 3105–8 (1959).

It is shown that indolacetic acid influences the incorporation of methyl into the methyl ester group of the cell wall pectin and also the formation of the anhydrogalacturonic acid residues of the pectic chain. Indolacetic acid also caused an accelerated synthesis of the water-sol. pectins during a 15-hr. incubation in 0.1*M* glucose. No such increase was noted in the hot water-insol. pectins. It is concluded that one function of indolacetic acid is to bring about increased formation of water-sol. pectic materials at the expense of the insol. cell wall pectic substances.

Retentate: A new scientific term.

TURNER, E. G. AND FEINBERG, J. G. *Nature 184*, 1139 (1959).

The authors introduce the word retentate for the substance retained in a dialysis sac. The words dialysate and diffusate are in use at present to describe the material leaving the sac. Heretofore, no single word has been used for the retained material.

Structure-activity relationships of anabolic steroids: Roles of the 19-methyl group.

SCHEDL, H. P., DELEA, C. AND BARTTER, F. C. (Natl. Insts. of Health, Bethesda, Md.). *J. Lab. Clin. Med. 19*, 921–35 (1959).

Anabolic agents are therapeutically effective in a variety of diseases, and dissociation of the anabolic from undesirable androgenic activity has been shown in several newer steroid derivs. One such modification is removal of the C-19-methyl group producing 19-nor compds. Each 19-nor compd. was compared with the analogous 19-methyl compd. (the only structural difference between pair members being presence or absence of the 19-methyl group) and with 17 α-methyltestosterone. Comparisons were made at two dosage levels in normal young women maintained on const. diets. All 19-nor compds. were strongly active in producing N retention, showing anabolic activity equiv. to that of 17 α-methyltestosterone by this assay procedure.

Microbiology

Inhibition of Clostridium botulinum by filtrates of Brevibacterium linens.

GRECZ, N., WAGENAAR, R. P. AND DACK, G. M. (Univ. of Chicago, Ill.). *J. Bacteriol. 78*, 506–10 (1959).

Culture fluids of two strains (ATCC 9174 and ATCC 9175) of *Brevibacterium linens* were shown to be inhibitory to germination and outgrowth of spores of *Clostridium botulinum* type A. The inhibitory agent could be produced by *B. linens* inoculated into aq. exts. of fresh cheese and in a soybean meal broth, but not in common lab. media. The level of the inhibitor in culture fluids of *B. linens* was highest on the seventh day of incubation and slowly decreased thereafter.

Studies on virulence of group A β-hemolytic streptococci.

LEEDON, J. M. AND BARKULIS, S. S. (Univ. of Illinois, Chicago). *J. Bacteriol. 78*, 687–94 (1959).

A strain of streptococcus of low virulence for mice has been subjected to serial mouse passage and virulent variant cultures recovered. There was reversion of colonial morphology from the smooth to the matt form on serial mouse passage. The virulence of the recovered organisms was markedly increased over the original culture. Studies on the fate in vivo of the 3 Q cultures showed quick disappearance of viable cocci of the Q496 culture when injected intraperitoneally into mice and rapid multiplication of cocci of the virulent cultures. These results were discussed with the tentative conclusions that the outstanding feature accompanying increased virulence on mouse passage was a marked change of gross colonial morphology assoed. with a considerably changed cell wall structure.

E. coli as vitamin producer and consumer.

HAENEL, H. AND SEMRAU, B. *Ernahrungsforschung 4*, 337–40 (1959).

Depending on the medium, *E. coli* is either a vitamin producer or consumer. It was inferred that corresponding differences occur in vivo.

The presumptive detection of some antibiotics in foods, using a sample microbiological test.

VAN DER MIJLL DEKKER, L. P., ET AL. (Central Inst. for Nutrition & Food Research, T.N.O., The Netherlands). *J. Sci. Food Agr. 10*, 475–8 (1959).

The food under investigation is mixed with double-strength agar contg. triphenyltetrazolium chloride as an indicator of bacterial growth. The agar dispersion so obtained is streak-inoculated with suitable test strains and incubated, using as a blank a mixt. of agar and an identical food sample known to be free from added antibiotics. For the presumptive detection of antibiotics *S. aureus* and *Strep. cremoris* are used as test organisms.

Use of enzymes in isolation and analysis of polysaccharides.

REESE, E. T. AND MANDELS, M. (Quartermaster Research and Eng. Center, Natick, Mass.). *Appl. Microbiol. 7*, 378–87 (1959).

This paper explores the possibility of applying the enzyme technique to the analysis of structural polysaccharides and evaluates the use of enzymes in isolation procedures.

Nutrition

The effect of dietary protein and fat on the changes of cholesterol levels in chicks.

KOKATNUR, M. G. *Dissertation Abstr. 20*, 1733 (1959).

An inverse relationship was found to exist between serum and carcass cholesterol levels and the protein intake. A high dietary fat level did not increase serum cholesterol levels unless the protein in the diet was at a subsequent level. The effect of dietary fat level on carcass cholesterol values was dependent on the type of fat. The lower the energy protein ratio the lower were the serum and carcass cholesterol levels. This effect was observed regardless of amt. and type of fat.

Nutritional value of turkey proteins.

YANG, S. P., CLARK, H. E. AND VAIL, G. E. (Purdue Univ., Indiana). *J. Am. Dietetic Assoc. 35*, 1251–4 (1959).

Describes a preliminary study detg. the nutritive value of the proteins in turkey meat for the growing rat when turkey meat was used as the sole source of protein. In a four-week period, the average food intake, wt. gain, and protein-efficiency ratio on diets contg. turkey meat at the 5 or 10% protein level were significantly greater than those on the comparable casein diets. There was no measurable difference between the nutritive value of these 2 proteins when fed at the 15 or 20% protein level. It is suggested that the nutritional superiority of turkey proteins over those of casein when fed at the lower levels of protein may be due to the difference in sulfur amino acid content.

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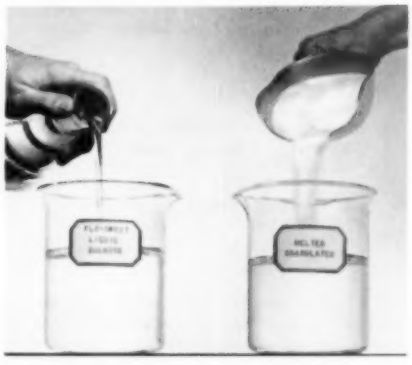

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Nutritional assessment of infants with hypochromic anemia.

WOODRUFF, C. W. (Vanderbilt Univ., Nashville, Tenn.). *Am. J. Clin. Nutrition 7*, 634–7 (1959).

Dietary histories on 27 infants with hypochromic anemia show excessive milk consumption with high calorie intake. Their diets appeared to be adequate in all nutrients but iron. The presence of iron deficiency in 10 infants having an iron intake of 5 to 7 mg./day indicates that such an intake may be inadequate for some infants. These studies emphasize the importance of iron-rich cereals and other foods in the diet of the infants for the prevention of dietary deficiency.

ENGINEERING RESEARCH

Industrial crystallization: Influence of chemical environment.

GARRETT, D. E. *Brit. Chem. Eng. 4*, 673–7 (1959).

A review of a number of reported uses of crystal habit modifiers, several new uses and how this phenomenon may be studied.

FOOD AND FOOD TECHNOLOGY

Bakery and Bakery Products

The effect of lysine supplementation on the protein efficiency of high-protein breads.

BROWN, J. W., ET AL. (E. I. du Pont de Nemours and Co., Wilmington, Del.). *Cereal Chem. 36*, 545–53 (1959).

Rat-growth studies were carried out with diets in which a comm. white bread and 3 representative types of comm. protein bread were the sole sources of protein, with and without lysine supplementation. The protein quality as measured by the protein efficiency ratio was found to be a direct function of the lysine content of the mixed protein, regardless of whether the lysine was a constituent of protein or was added as L-lysine monohydrochloride. It appears necessary that the bread protein contain at least 200 mg. of L-lysine/g. of nitrogen.

Development of the leavening system for an instant bread mix.

MILLER, J. A., MCWILLIAMS, C. S. AND MATZ, S. A. (Victor Chem. Works, Chicago Heights, Ill.). *Cereal Chem. 36*, 487–97 (1959).

A leavening system consisting of 3.5% $NaHCO_3$ and 9% glucono-delta-lactone (flour basis) has been developed for a bread mix which requires only 10 mins. to prepare from the time of addn. of water to insertion of dough into the oven. The baked item produced from this mix closely resembles yeast-leavened bread in grain, texture, volume, and appearance, but not in flavor. Variations in $NaHCO_3$, acid and total leavening indicated optimum performance at approximately 3.5% $NaHCO_3$, 9% acid, and between 12 and 15% total leavening based on the flour weight.

Cocoa

Processing of raw cocoa. III. Enzymic aspects of cocoa fermentation.

HOLDEN, M. *J. Sci. Food Agr. 10*, 691–700 (1959).

The changes in the levels of a number of oxidizing and carbohydrate-splitting enzymes of Amelonado cacao bean cotyledons during both large- and small-scale fermentations were detd., on samples of beans taken after various periods of fermentation from the top and center of heaps of different sizes. Inactivation of enzymes took place sooner in the top layer, where the temp. rise was more rapid, than at the center. Enzyme levels started to diminish during the period when the beans were dying and continued until, after 3 days' fermentation, little or no activity was detectable. The results suggest that prolonging fermentation for several days after the beans are dead is neither necessary nor desirable.

Fats and Oils

Nutritional evaluation of some heated oils.

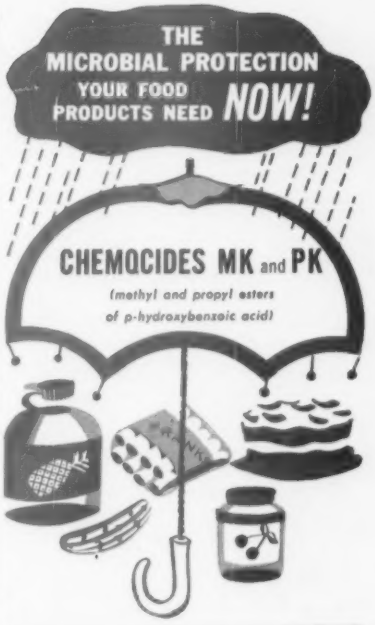
ALFIN-SLATER, R. B., AUERBACH, S. AND AFTERGOOD, L. (Univ. of Southern California, Los Angeles). *J. Am. Oil Chemists' Soc. 36*, 638–41 (1959).

No evidence of impaired nutrition or harmfulness was observed in any group except in those fed the more highly polymerized soybean oil, where a decrease in iodine value of 10% and a 100% increase in viscosity was assocd. with a slight depression in growth and an interference with reproductive performance in the female animal. Digestibility of the heated soybean and cottonseed oils was only slightly reduced.

Determination of cis unsaturation in oils by near infrared spectroscopy.

FENTON, A. J. AND CRISLER, R. O. (Procter and Gamble Co., Cincinnati, Ohio). *J. Am. Oil Chemists' Soc. 36*, 620–3 (1959).

The method depends upon the measurement of a band in the near infrared at 2.143 μ that is caused by cis unsatn. The areas under the absorption bands for cis polyenes are integral multiples of the areas under the bands of cis monoenes. The cis content of oils contg. less than 10% trans triglycerides can be detd. accurately by measuring the area under the absorption band. Accurate results can be obtained for samples contg. quantities of trans fatty acids in excess of 10% if a point baseline is used and the peak absorbance measured.



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Feedstuffs

Industrial production of vegetable protein.

ANON. *Chem. & Ind. 1343* (1959).

British Glues and Chemicals, Ltd. have demonstrated their pilot plant process for production of edible protein from vegetable matter such as grass, maize, peanuts or cottonseed. The material is extd. with dil. sodium carbonate soln. The protein is pptd. out with acid and centrifuged. A continuous dryer is in design. Grass gives a 5½% yield with 50% protein.

Meat

Steak making process.

SULLIVAN, W. R., CLEARY, P. J. AND LOVE, D. B. Assignors to Armour and Co. U. S. 2,917,388. Dec. 15, 1959.

A mixt. of ground lean beef with ground fat beef as a binder is extruded into elongated meat bodies without emulsifying the fat, rapidly frozen, tempered to 26 to 30° F. and cut into ⅜ to ⅝ in. slices. Finally a reticulated pattern is impressed into both sides of each slice.

Starch

The iodine affinity of β-amylase treated and aged potato amylose.

CEH, M. *Die Starke 11*, 315–18 (1959).

The amt. of iodine bound to fresh and aged amylose, resp., previously degraded by β-amylase, was detd. by amperometrical titration. The results indicate that β-amylolysis may be interpreted as follows: any amylose chain is first completely degraded to maltose by an enzyme molecule which attacks another molecule afterwards. During the aging process amylose molecules form aggregates and the introduction of iodine into these aggregates is hindered. The aged amyloses and their hydrolysates could be regenerated by NaOH soln. The same sorption ability for iodine was observed with the regenerated samples as with the fresh ones.

Structure of the starch granule. I. Swelling and solubility patterns of various starches.

LEACH, H. W., MCOWEN, L. D. AND SCHOCH, T. J. (Corn Products Co., Argo, Ill.). *Cereal Chem. 36*, 534–44 (1959).

The modes of swelling of various starches have been evaluated over a range of pasting temps., to provide evidence of the associative bonding within the granule. Corn and milo starches show a limited two-stage swelling, indicative of 2 sets of bonding forces which relax at different temps. In contrast, potato starch undergoes very rapid and unrestricted swelling at relatively low temp., indicating weak and uniform bonding.

POLYMER RESEARCH

Investigations of the phenomena of coacervation.

TURSKA, E. AND UTRACKI, L. *J. Appl. Polymer Sci. 2*, 46–55 (1959).

A coacervate is defined as a second phase richer in solute formed from a one phase multi-component liquid soln. upon further addn. of the non-solvent component. The technique of coacervation has been found useful in the fractionation of polymers. The paper describes a technique whereby coacervation may be distirguished from simple phase sepn. due to limited soly.

The spreading of liquids on polyethylene film. The effect of preprinting treatments.

ALLAN, A. J. G. (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). *J. Polymer Sci. 38*, 297–306 (1959).

A study has been made of the wettability of thin films of polyethylene by observing the equilibrium advancing contact angle formed by a drop of liquid on the surface. It is shown that an essential criterion for good ink adhesion is the complete wetting of the film surface by the ink.

INDUSTRY NEWS

R and D Associates to Hold Major Conference in Chicago

The Fourteenth Annual Meeting of the Research and Development Associates, Food and Container Institute, Inc., to be held on April 19, 20, 21, the Congress Hotel, Chicago, will bring together several hundred research, management, and military personnel whose interests lie in the food and packaging fields. Represented at the meeting will be food and packaging researchers from industry, university, Government and foundation laboratories, and from the Army, Navy, and Air Force. Agenda for the three-day meeting includes a review of progress on food and container projects of the Quartermaster Food and Container Institute, including such new military developments as quick-serve meals, "contour packaging," and special packaging requirements for the "thru-flow" of military supplies. Colonel James P. Littlejohn, QMC, is Commandant of the QM Food and Container Institute for the Armed Forces, and Dr. F. P. Mehrlich, Scientific Director of the Organization.

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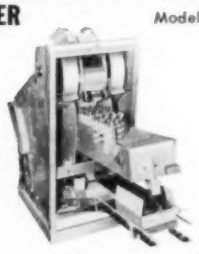

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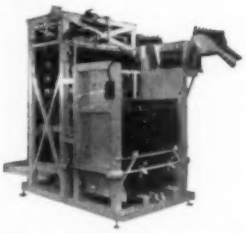

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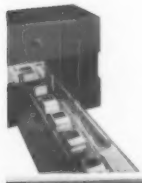

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3. **Aperture is split for easy installation over conveyor.**
4. **Extremely reliable; anti-drift circuit for high stability.**

   This new, completely redesigned RCA Metal Detector offers food processors today's most effective and dependable safeguard against tramp metal. Any metallic particle, even as small as a period in this copy, is detected by this device which can be wired to actuate a warning signal light or rejection gate, or momentarily stop the flow of material. New split aperture construction permits fast installation without interfering with production operations.
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7. **Backed by RCA's nationwide service facilities.**

SENSITIVITY TABLE

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		Magnetic Metal (Steel)	Non-Magnetic Low-Resistance Metal (Brass, Copper, Aluminum)	Non-Magnetic High-Resistance Metal (Stainless Steel, Monel)
S-850	3½" x 8½"	0.062	0.106	0.156
S-850A	2" x 8½"	0.039	0.060	0.115
S-850B	6" x 8½"	0.090	0.140	0.192
S-418	4" x 18"	0.062	0.106	0.156
S-418A	2" x 18"	0.047	0.070	0.132

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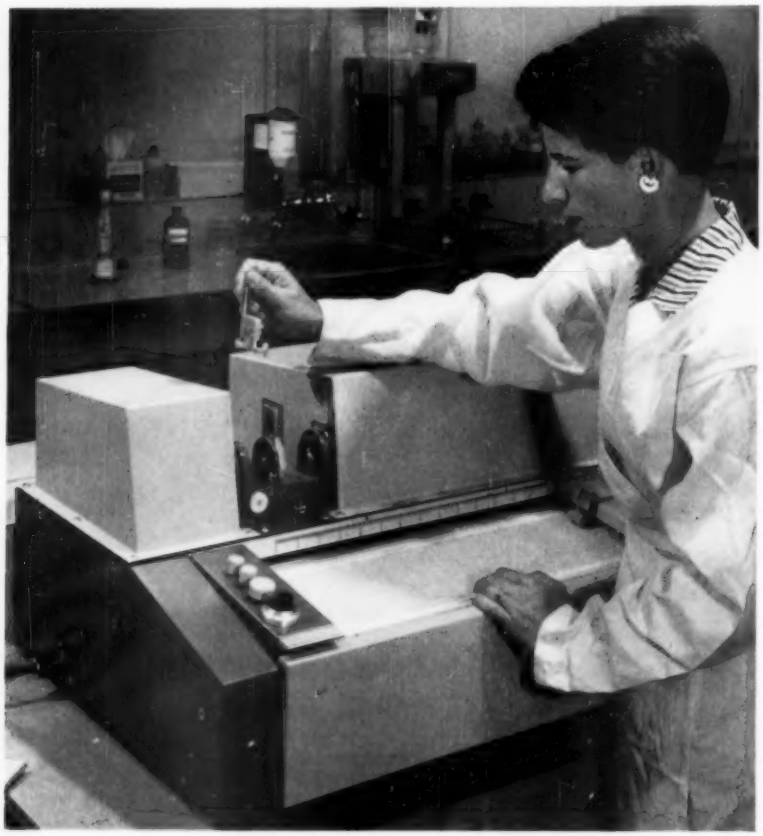
The Associates is a non-profit organization devoted to facilitating liaison between the Military and industry on problems arising from the unique design of material or unusual manufacturing requirements for Armed Forces rations and containers. Mr. Weld Conley, manager of research and development for Chain Belt of Milwaukee, is the president.

On the first day, Tuesday, April 19, Major General Andrew T. McNamara, The Quartermaster General, U. S. Army, will address the group on Quartermaster Corps objectives. Featured speaker for the Wednesday luncheon is Captain S. Boozer, SC, U. S. Navy, Commanding Officer, Navy Subsistence Office. Dr. Philip L. White, secretary, Council on Foods and Nutrition, American Medical Association, will speak on "Nutritional Education and Nutritional Advertising" on Friday.



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IN MEMORIAM

Dr. Rae H. Harris, head of the Department of Cereal Technology at North Dakota State College at Fargo for many years died unexpectedly of a heart attack on February 25, 1960. Dr. Harris worked diligently to inspire interest in cereal technology in his area and gave special attention to furthering research on the properties of wheat and other cereal crops of the Northern Great Plains area. He published widely in the professional journals. During the 1950's his efforts to obtain a modern laboratory for prosecuting the study of cereal technology and research on wheat varieties grown in North Dakota were successful, and it was possible to expand the program. Dr. Harris will be greatly missed but his contributions to his state and region will long be felt.

PERSONNEL

Appointment of **Paul M. Cormack** as technical representative in the metropolitan New York City area for Sterwin Chemicals Inc. has recently been announced. Mr. Cormack, who received B.S. and M.S. degrees from Syracuse University, will handle the complete Sterwin line of products, calling on users of vanillin, certified food colors and vitamins for food enrichment. His sales territory is to include Westchester County, Long Island and parts of New Jersey, as well as New York City. Before joining Sterwin, Mr. Cormack was associated with H. J. Heinz Company in Pittsburgh as a microbiologist, and at the firm's Medina, N. Y. plant as laboratory supervisor and bacteriologist. He was previously employed by the Lucidol Division, Wallace and Tiernan, Inc.

P. M. Cormack

Ray B. Wakefield, IFT President, has been promoted within Gerber Products Company to Vice President-Research, according to a recent announcement by Daniel F. Gerber, President of the company. President Wakefield has been with Gerber since 1932, and was named laboratory director in 1939, and in 1946 was promoted to director of research and quality control. A Charter Professional Member of the Institute, he has been on the Executive Committee in 1952–53, and 1955 to date. He was also General Arrangements Committee Chairman of the 1952 Annual Meeting, Institute Treasurer from 1956 to 1958, and Chairman of the Publications Committee from 1953 to 1956. Prior to joining Gerber, Mr. Wakefield earned a B.Ch.E. and M.S. from the University of Minnesota in 1931 and 1932 respectively. He also earned a Ch.E. degree from the same school in 1937.

R. B. Wakefield

Secretary Benson Names Dr. Newton Co-ordinator on Utilization Research.

Secretary of Agriculture Ezra Taft Benson has announced appointment of Dr. Roy Chester Newton, retired scientist who operates a farm at Three Rivers, Mich., to a newly-created position of co-ordinator for utilization research. Dr. Newton, a native of El Reno, Okla., holds a Ph.D. in chemistry from the University of Chicago. At the time of his retirement on May 1, 1959, he was vice-president in charge of research for Swift & Company. The appointment, Secretary Benson said, further emphasizes research within the Department of Agriculture to find new industrial outlets, for profitable use of agricultural commodities, and especially those that may be in surplus. "Dr. Newton's intimate knowledge of industry needs for raw materials in production of food, fiber, and especially industrial products will be particularly valuable to the Department at this time," Secretary Benson said. "The sound counsel he can provide can contribute significantly to our research program." The new co-ordinator will be responsible for continuing review of all utilization research and development work, including that being done under Federal grant funds and under contracts and grants in institutions in the United States and abroad. Dr. Newton has been a leader in the industrial utilization field for many years.

R. C. Newton

Stanley M. Osri, a Division Research Manager of the National Dairy research center in Glenview, Illinois was honored for 20 years of service with the company on Jan. 25, 1960. The award, diamond cuff links, was presented along with a service citation certificate by **Charles W. Kaufman,** Director of Research. Osri is a graduate of Illinois Institute of Technology, where he majored in Chemical Engineering and obtained his B.S. degree in 1938.

S. M. Osri

Three Institute members, **Dr. Eric J. Hewitt, Dr. Donald A. M. Mackay,** and **Dr. Kurt S. Konigsbacher,** all of Evans Research and Development Corporation, have been instrumental in food flavor research which resulted in a United States Patent for an enzyme process to enhance the natural fresh flavor in processed foods. Dr. Torsten Hasselstrom of the Army Quartermaster Research and

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VICO BF Flavors developed and compounded by specialists skilled in flavor processing for over 25 years provide tempting aroma and appetite stimulating meat-like flavor. Completely water soluble, they are offered in dry or paste form.

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Engineering Command also did basic work in the project which was sponsored both by the United States Government and private industry.

Dr. John H. Silliker has been named chief biologist and associate director of Swift & Company's Research Laboratories. He has jurisdiction over the analytical bacteriology, research bacteriology, biochemistry - nutrition and veterinary divisions. Dr. Silliker started with Swift in 1953 at the Research Laboratories in Chicago. The following year, he was appointed co-ordinator of bacteriology, and in 1958, was named chief bacteriologist.

Dr. J. H. Silliker

Mead Johnson & Company, nutritional and pharmaceutical manufacturer, recently announced the appointment of **Theodore R. LaBree** as Associate Bacteriologist in the firm's Control Laboratory. Mr. LaBree, a native of West Lafayette, Indiana, received an M.S. degree in Food Technology from Purdue University in January 1960.

William F. Massmann, Dr. Pepper Company's director of research and quality control, recently announced the appointment of **Charles P. Grier** to head up the quality control laboratory in the firm's national headquarters in Dallas, Texas. He joins the company after serving on the technical staff of the American Bottlers of Carbonated Beverages in Washington, D. C. for the past six years. Grier is a native of Arkansas City, Kansas, and attended schools in Montverdo, Florida and Tacoma Park, Maryland, before receiving his Bachelor of Science degree in Bacteriology from the University of Maryland in 1954. He and Mrs. Grier and their son John, 2, are making their home in Dallas.

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Opportunities exist in the Canned Food Research Department of a major corporation for Food Technologist or Food Engineer with experience in canned meats research and development. Background in Quality Control or Technical Service would be helpful. REPLY BOX 776, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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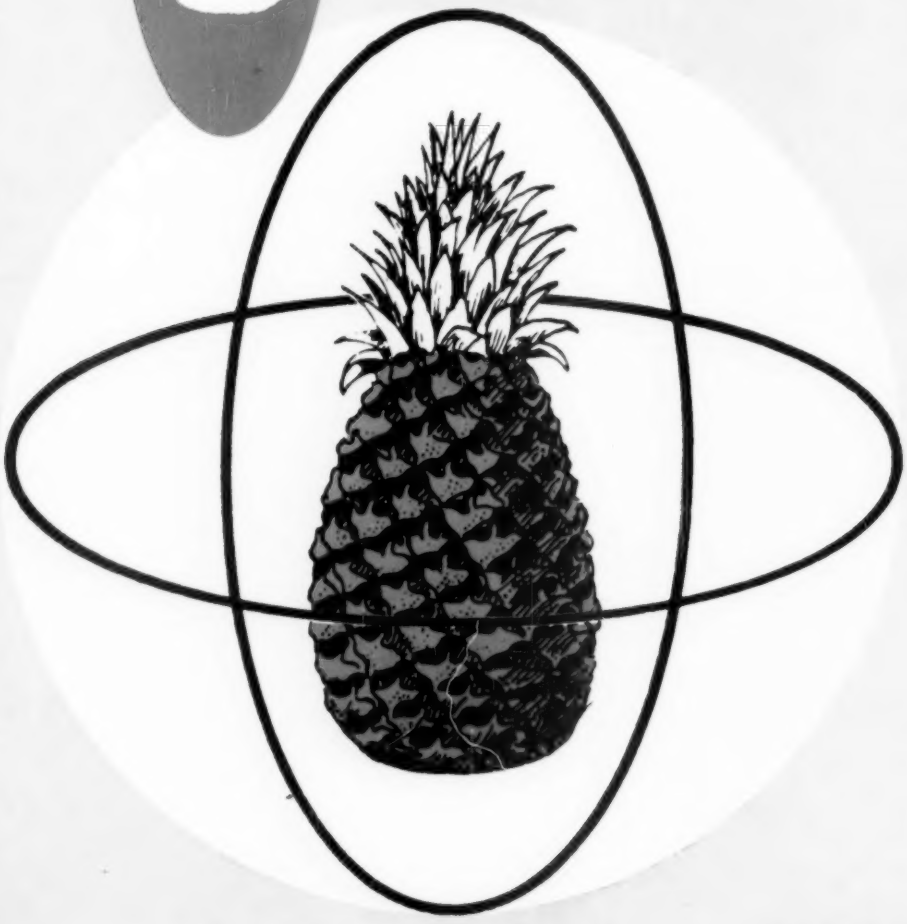

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